FINAL

DAMAGE ASSESSMENT AND RESTORATION PLAN AND ENVIRONMENTAL ASSESSMENT FOR THE DECEMBER 7, 1997 ALAFIA RIVER SPILL

PREPARED BY

ENVIRONMENTAL PROTECTION COMMISSION OF HILLSBOROUGH COUNTY
FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
POLK COUNTY, NATURAL RESOURCES
UNITED STATES FISH & WILDLIFE SERVICE

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1.0 INTRODUCTION

This Damage Assessment and Restoration Plan and Environmental Assessment (DARP/EA) has been developed by State, County and Federal agencies to address the injury to, loss of, destruction of, and lost use of natural resources resulting from Mulberry Phosphates, Inc.'s (MPI) December 7, 1997 spill of acidic process water into the Alafia River. This plan identifies the assessment methods and restoration actions which the agencies plan to use as the basis for assessing natural resource damages for this spill event. This plan seeks to compensate for the natural resource injuries and resource service losses which occurred through appropriate restoration actions. The purpose of restoration under this plan is to make the public whole for injuries or losses resulting from the spill by ensuring that injured natural resources or services return to pre-spill, or baseline, conditions and by providing for restoration or replacement of resources or resource services in order to compensate for interim losses of resources or resource services caused by the spill.

This DARP/EA:

- Describes the accidental release of acidic process water which occurred on December 7, 1997 and the natural resource injuries and losses which resulted from that release,

- Identifies the procedures used to document and quantify those natural resource injuries and losses,

- Establishes objectives for restoring these injuries and losses,

- Identifies and evaluates a reasonable number of restoration alternatives appropriate to achieving restoration objectives for these injuries and losses,

- Identifies the restoration actions which the Agencies plan to use to restore natural resources or services to compensate for the natural resource injuries and losses which occurred,

- Identifies the methods which will be used to scale those proposed restoration actions, to compensate for the resource injuries and losses,

- Identifies the methods which will be used to calculate the costs of implementing selected restoration actions.

1.1 Authority

The DARP/EA has been prepared jointly by the Florida Department of Environmental Protection (DEP), the Environmental Protection Commission of Hillsborough County (EPC), Polk County, Natural Resources and Drainage Division (Polk County), the National Oceanic and Atmospheric Administration (NOAA), and the U.S. Fish and Wildlife Service (FWS) on behalf of the

U.S. Department of the Interior (DOI) (collectively "the Agencies"). DEP, NOAA, and DOI are acting under their authority as natural resource trustees under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), as amended, 42 U.S.C. § 9601 et seq., the Federal Water Pollution Control Act, 33 U.S.C. §1251 et seq., (also known as the Clean Water Act or CWA) and other applicable Federal law including the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) Subpart G, 40 C.F.R. Sections 300.600 - 300.615 and regulations at 43 C.F.R. Part 11 which are applicable to natural resource damage assessments under CERCLA. In addition, DEP is acting pursuant to authority provided by Chapters 376 and 403, Florida Statutes, and other applicable provisions of State law. EPC is acting pursuant to Chapter 84-446, Laws of Florida, as amended, and Section 403.182, Florida Statutes. Polk County is acting in accordance with Polk County Ordinance 93-06 and other applicable regulations. Each Agency is authorized under applicable authorities to assess and recover natural resource damages for this spill event and to base that assessment on the costs to restore, replace or acquire the equivalent of the injured resources, and lost resource services.

1.2 Coordination with Responsible Party

Under CERCLA and state laws, the party responsible for a spill such as this ('responsible party' or RP) is liable for any injuries to natural resources resulting from the release.

An RP may participate in a natural resource damage assessment process. Regulations applicable to assessments under CERCLA indicate an RP is to be notified of an agency's intent to proceed with an assessment and invited to participate in the development and performance of that assessment. 43. C.F.R. 11.32(a)(2)(iii). An RP may contribute to an assessment in many ways. The nature and extent of such participation, however, is subject to substantial agency discretion. 43 C.F.R. 11.32(c). The final authority to make assessment and restoration determinations rests solely with the agency(ies) conducting the assessment. Agencies operating under State or local laws may exercise similar discretion, as appropriate.

MPI has been actively involved in the assessment process for this spill event. MPI has provided a substantial amount of data and other information bearing on the nature and extent of the spill's impacts on the river system, including data from sediment and benthic sampling and information from surveys undertaken to assess potential injuries to vegetation, fish, and other species within the system. This information has been considered by the Agencies in the development of this DARP/EA. In February 1998, the Agencies met with MPI representatives to invite and encourage a cooperative, restoration-focused approach to completing the damage assessment. Since that time, MPI has proposed assessment strategies and restoration options for consideration by the Agencies and has submitted comments on assessment data, methodologies, draft memoranda, draft analyses and draft estimates relating to injuries or losses of natural resources injuries being considered by the Agencies. MPI representatives have also participated on the Agencies' Restoration Subgroup, which coordinated the scoping, screening and evaluation of restoration alternatives for identified resource injuries. The Agencies also used the Restoration Subgroup to coordinate the development of this DARP/EA, allowing MPI to review and comment on the document as it was being developed.

In addition to its participation in the assessment process, MPI submitted comments to the Agencies during the period for public review and comment on the Draft DARP/EA.

1.3 Public Participation

On October 7, 1998, the Agencies published a Public Notice in the Tampa Tribune, entitled "Notice of Intent to Perform Damage Assessment/Develop Restoration Plan for the "Mulberry Phosphates, Inc./Alafia River Spill of December 7, 1997". That notice sought input from the public on the restoration alternatives which should be considered in the development of this DARP/EA. The notice identified the spill event, the Agencies involved, the natural resources and resource services being considered in the assessment process, criteria developed for use to evaluate restoration actions within the assessment process, and the restoration options identified for consideration by the Agencies as of that date.

The Agencies received three submissions from the public as a result of this early notice. These submissions identified several candidate restoration projects, each of which was consistent with one or more of the restoration alternatives already identified by the Agencies for consideration in developing a DARP/EA. A list of potential projects identified during this scoping process and their relation to each restoration alternative considered in the Draft DARP/EA was provided in Appendix C of that document.

The Draft DARP/EA was released for public review and comment for 30 days on July 22, 1999. The Draft DARP/EA was the means by which the Agencies sought public comment on the analyses used to define and quantify the resource injuries and service losses which occurred as well as on the restoration actions which the Agencies proposed for use to compensate for those injuries and losses. Public review of the Draft DARP/EA is either permitted by or is consistent with all federal, state or local laws applicable to the process of assessing damages for this incident, including the regulations guiding natural resource damage assessments under CERCLA, 43 C.F.R. Part 11, the National Environmental Policy Act (NEPA) 42 U.S.C. §4371, et seq., and the regulations implementing NEPA at 40 C.F.R. Part 1500.

Comments received during the public comment period were considered by the Agencies prior to finalizing this DARP/EA. A summary of comments received and the Agencies' responses there to are included in Appendices D and E of this final DARP/EA.

1.4 NEPA Compliance

The development of the restoration plan within this DARP/EA is subject to NEPA, 42 U.S.C. §4321, et seq., and regulations guiding its implementation at 40 C.F.R. Part 1500. To comply with

NEPA and its implementing regulations, the development of the DARP/EA summarizes the current environmental setting, the purpose and need for the proposed restoration actions, alternative restoration actions, their applicability and environmental consequences, and provided for public participation in the decision process.

NOAA and DOI have reviewed this DARP/EA for consistency with NEPA requirements, and the impact of the identified restoration actions on the quality of the human environment. This review is contained in Section 6.0 of this DARP/EA.

1.5 Administrative Record

The Agencies have each maintained records documenting actions taken and information considered by the Agencies as they have proceeded with assessment and restoration planning activities for this incident. These records are available for review by interested members of the public. To access or view the records for each agency, interested persons should contact:

< John Iliff
NOAA Restoration Center
9721 Executive Center Dr. N., Suite 114
St. Petersburg, FL 33702
727-570-5391/Fax: 727-570-5390.

< Sam Zamani
Administrator, DEP Phosphate Management
3804 Coconut Palm Drive
Tampa, FL 33619
813-744-6100, ext. 148/Fax: 813-744-6457

< Chris Dunn
Director, EPC Water Management Div.
1900 9th Avenue
Tampa, FL 33605
813-272-5960/Fax: 813-272-5157

< Joe King
Polk County, Natural Resources Div.
4177 Ben Durrance Road
Bartow, FL
941-534-7377/Fax: 941-534-7368

< Erik L. Orsak
Environmental Contaminants Specialist
U.S. Fish and Wildlife Service
1510 North Decatur Boulevard
Las Vegas, Nevada 89108
702-647-5230/Fax: 702-647-5231

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2.0 OVERVIEW OF THE DECEMBER 7, 1997 ALAFIA RIVER SPILL

2.1 Description of the December 7, 1997 Spill Incident

On December 7, 1997, a breach occurred in the wall of a phosphogypsum stack located at the MPI phosphoric acid/fertilizer production facility in Mulberry, Polk County**,** Florida. As a result of this breach, approximately 50-56 million gallons of acidic process water flowed from the top of the stack, overflowed return and collection systems associated with the stack, and flowed into and through Skinned Sapling Creek into the Alafia River. Over the course of the next week to 10 days, the volume of released process water traversed approximately 36 miles of the river to Tampa Bay. Information collected by the U.S. Environmental Protection Agency (EPA), DEP, and EPC indicates the released process water contained about 1.5% phosphoric acid, and exhibited a pH of approximately 2 standard units. The material released also contained or was comprised of one or more substances designated as hazardous under CERCLA, including phosphoric acid.

The released process water lowered the pH along 35 miles of the Alafia River to levels ranging from approximately 2.3 standard units in the upper, freshwater portion of the Alafia River to 3.0-4.0 standard units in the lower, 10 mile estuarine portion for several days. The released process water caused a fish kill in the Alafia River, readily observable injuries to shoreline and upland vegetation in some areas in Polk County, and injuries to other natural resources, including losses of resource services.

Response actions were coordinated and carried out by and between MPI, EPA, DEP, EPC and other agencies. These actions were sufficient to stop the source of the release, to monitor the movement of the released process water as it moved toward and into Tampa Bay from the spill site, to document the effects of the release on certain surface water quality parameters, to protect the public from potential risks associated with uses of the river during the spill event, and to allow some actions to try and minimize potential effects of the spill. These actions could not, however, prevent natural resource injuries and losses from occurring; likewise, these actions did not operate to restore or compensate for these injuries and losses.

2.2 Affected Environments: The Alafia River and Tampa Bay

This section provides brief descriptions of the physical and biological environments that may be affected by restoration actions, consistent with NEPA. The descriptions include environments affected or potentially affected by the spill and targeted for restoration activities. The physical environment includes the surface waters of the Alafia River, associated freshwater wetlands and estuarine habitats and surface waters and habitats in Tampa Bay. The biological environment includes a wide variety of fish, shellfish, wetland vegetation, birds and other organisms.

2.2.1 Physical Environments

Alafia River: Historically, the Alafia River watershed was once composed of a wide variety of upland and coastal habitats. Within the last century, many large tracts have been converted from natural land features to phosphate mines, predominantly in the easternmost portions of the watershed. A detailed study conducted in the early 1970s suggested that approximately 47% of the watershed had been developed at that time (Dames & Moore, 1975). By the early 1990s, over 91% of the watershed had been altered by human activities, with 74% of the watershed impacted by mining activities and approximately 17% developed for urban, suburban, commercial, industrial and agricultural uses.

The Alafia River flows east to west and originates from both lower Hillsborough County and western Polk County. The river is characterized by a main flowing river and two large tributaries, the North and South Prongs originating in the northeast and southeast portions of the watershed, respectively. Perennially flowing and intermittent tributaries to the Alafia River include: Skinned Sapling Creek, Buckhorn Creek, Turkey Creek, English Creek, Poley Creek, Thirtymile Creek, Sloman Branch, West Branch, Mizzelle Creek, Owens Creek, Halls Branch, Chito Branch, McCollough Branch, Fishhawk Creek, Coleman Hammock, Little Fishhawk Creek, Bell Creek, and Rice Creek. Additional freshwater flows originate from Lithia Springs, approximately 15 miles upstream, and from Buckhorn Springs, approximately 8 miles from the mouth of the Alafia River.

The Alafia River can be divided into four general sections or reaches: lower, middle, North Prong, and South Prong. The lower reaches of the Alafia River extend from the river's mouth at Tampa Bay to approximately five miles upstream where the river narrows and becomes less tidally influenced. Floodplain habitat along this section of the river has been developed largely into single family and estate homes; areas that remain are typically small, isolated fragments of forest and are used as municipal parks and recreation areas or are held under private ownership.

The middle reaches of the Alafia River extend from the confluence of the North and South Prongs downstream to the U.S. Highway 301 bridge. This segment is characterized by a relatively narrow river width and more extensive undeveloped floodplain habitats. The North Prong of the river extends northeasterly approximately 10 miles with several branching tributaries extending east and west. The South Prong extends approximately 25 miles south and then east after branching from the main river. The eastern portions of the South Prong have been heavily mined.

The river in the vicinity of the MPI facility, the site of the release, is a shallow, broad, freshwater marsh. The gypsum stack that failed rises about 100-115 feet above this marsh environment. Skinned Sapling Creek lies just south of the gypsum stack and flows west, connecting to the North Prong of the Alafia River.

Tampa Bay: Located on the west central coast of Florida, Tampa Bay is the State’s largest open water estuary. This roughly y-shaped estuary covers almost 400 square miles and can be subdivided into 6 named bays (Hillsborough, Old Tampa Bay, Middle Tampa Bay, Lower Tampa

Bay, Boca Ciega Bay, and Terra Ceia Bay). The Tampa Bay watershed spans 2,300 square miles of 6 different counties. Due to the large influence of rivers and tributaries that drain into the Tampa Bay, activities in its watershed directly affect the health of the Bay .

The Alafia River discharges into Hillsborough Bay, along with the Hillsborough and Palm River. Hillsborough Bay is surrounded by the City of Tampa and has a major port located in its northern reach.

2.2.2 Biological Environments

The Alafia River is a riverine ecosystem with numerous tributaries and springs discharging into the system. Small headwater streams provide habitat to organisms ranging from small invertebrates to game sized largemouth bass. Deepwater pools provide habitat to fish such as channel catfish. Low and medium salinity habitats created by the Alafia River and Hillsborough Bay provide critical nursery habitat at early stages of development for numerous commercial and recreational fish such as snook, red drum, mullet, tarpon, ladyfish, and spotted seatrout. Shellfish such as American oyster, blue crab, stone crab, and pink shrimp can be found in the estuarine parts of the river.

The freshwater wetlands and marshes of the upper Alafia River provide numerous resource services. Among the more commonly identified functions of these wetlands, are food web support, water quality maintenance, and wildlife habitat. Detritus produced by wetland vegetation provides food resources to microbial and protozoan communities which act as food for invertebrates, which in turn act as food for fish. Wetland vegetation enhances water quality through the removal and uptake of nitrogen and phosphorus, which at low levels serve as nutrients but in higher concentrations are pollutants. Wetland vegetation, whether herbaceous, shrub or canopy species, provides cover for wildlife which is an important habitat characteristic.

Nuisance vegetation characterizes much of the freshwater wetland landscape injured by the spill. Nuisance vegetation are species native to a region, but occurring in disproportionate abundance. Wetlands with nuisance species, such as those injured by the spill, do provide resource services**,** such as nutrient absorption/filtering. However, the level of some services, such as wildlife habitat, is low when compared to non-nuisance dominated wetlands.

The open waters of Tampa Bay provide important habitat for the estuarine dependant fish species, such as those mentioned above, as well as marine fish species, marine mammals (e.g., bottlenose dolphin and the West Indian Manatee) and seabirds. Other important habitats within Tampa and Hillsborough Bays are seagrass meadows, tidal marshes, salt barrens, oyster bars and mangrove forests.

Appendix A lists some of the important species occurring within Hillsborough and Polk Counties that may utilize the Alafia River watershed and/or Tampa Bay designated by either State or Federal laws as Threatened **(T)**, Endangered **(E),** or Species of Special Concern **(SSC)**. The Agencies did not document injury to any of the listed species presented in Appendix A.

2.2.3 Cultural Environment and Human Use

Tourism and recreation are major Florida industries. Water-related recreational activities common on the Alafia River and Tampa Bay, include recreational fishing, swimming, canoeing and other boating activities. These activities are important to tourists and permanent residents alike. Currently, there are well over 100,000 registered boaters in the Tampa Bay area (DEP, 1998a) and over 200 public and private marinas. Boat ramps and parks occur along the Alafia River. They include Williams, Riverview, Lithia Springs, and Alderman Ford parks and the Alafia River boat ramp. Recreational activities on the Alafia River and Tampa Bay also support businesses, such as bait shops and boat rental facilities. Several such businesses are sited along the Alafia River.

Agriculture, boat building, and port activities are some of the historic and current industries that have shaped Tampa Bay. Tampa Bay is the largest port in Florida and the eleventh largest port in the United States (Tampa Port Authority, 1999). It supports important industries, such as phosphate mining, by providing affordable bulk transportation. Phosphate and related products comprises 49% of all Tampa Bay exports (Tampa Port Authority, 1997). Now, as in the past, fishing plays an important role in Tampa Bay, with commercial fish and shellfish landings in Hillsborough County at 3,519,912 pounds during 1997 (Bureau of Economic and Business Research, 1997).

2.3 Summary of Preassessment Activities

Following the release on December 7, the Agencies acted quickly to identify and, to the extent practicable, coordinate activities to collect data and other ephemeral information which would be needed to document the spill and assess its potential to adversely affect natural resources. These efforts took into account investigations being undertaken by MPI, EPA and DEP as part of the spill response, natural resources at risk, preexisting monitoring programs for resources of concern, and the different capabilities, human resources and expertise of the agencies investigating the resource injuries. In coordinating and initiating investigations of potential natural resource injuries, the Agencies faced significant time, resource and logistic considerations due to the nature of the event. As a result, a number of different agencies and MPI were sources of information which the Agencies considered in the investigation of natural resource injuries. Relevant activities included:

- Documentation of the spill and its movement through the Alafia River,
- Surface water sampling to assess injury to surface waters and to document pathways of resource exposure,
- Visual surveys to identify and assess resource mortalities,
- Supplementation of state monitoring program to identify and assist in assessing small fish mortalities,
- Benthic sampling to evaluate potential effects to benthic communities,
- Ground reconnaissance, systematic field sampling and aerial photographic surveys to assess impacts to shoreline, wetland and upland vegetation.

Further details and results of these investigations for specific natural resources are presented in Sections 3.0 and 4.0.

2.4 Natural Resources and Resource Services Injured

Based on information provided by preassessment investigations, the Agencies have identified five types of natural resource injuries or losses warranting further assessment consideration in developing this DARP/EA:

1) Freshwater Wetlands: Approximately 377 acres of wetland vegetation situated between the site of the release and the Keysville Bridge experienced some observable die-off as a result of contact with the acidic process water release. The die-off of vegetation represents a loss of associated ecological services, until the areas recover to pre-spill conditions.

2) Fish, Crab, and Shrimp: The spill-induced acidity in the surface waters of the river caused an instantaneous fish, crab, and shrimp kill in the river. The fish, crab, and shrimp kill also represent a corresponding loss of future production for affected species.

3) Surface Water: The release demonstrably injured the physical and chemical quality of the surface waters of the Alafia River. It substantially reduced pH in the river to levels below water quality criteria established under both state and federal law for the support of aquatic life and recreation. The release also added nutrients, such as phosphorus and nitrogen, in amounts sufficient to cause or contribute to an imbalance in the natural populations of aquatic flora and fauna, particularly in phytoplankton in the surface waters of the Alafia River and portions of Tampa Bay for several months, contrary to a narrative water quality criterion established under State law.

4) Freshwater Benthic Invertebrates - When compared to control and background stations, sampling stations downstream from the spill site demonstrated reduced benthic species abundance and diversity after the spill. This evidences an injury to freshwater benthic communities.

5) Oysters and Mussels - Following the spill, EPC conducted surveys of two created oyster reefs in the lower Alafia River and found approximately 30% mortality on one of these reefs. EPC also observed and documented through photographs that the mussel population that had been growing on the I-75 bridge pilings was also dead after the spill.

2.5 Natural Resources and Resource Services with Significant Potential for Injury

The Agencies also identified two types of natural resources or resource services with a significant potential for injury or loss due to the spill:

1) Birds - Following the spill, FWS personnel investigated the potential for direct or indirect injuries to bird species. This included a search of historical wildlife data, GIS database analysis, and consultation with FDEP, Florida Game and Freshwater Fish Commission (FGFC) and National

Audubon Society (NAS) personnel on species within or using the spill area and the potential for adverse impacts. FWS biologists also conducted an inspection of the spill area in January 1998. GIS data confirmed the presence of several bird colonies throughout the Alafia river corridor, including nesting sites for the bald eagle and osprey. Further, over 25 avian species were confirmed using the area between U.S. Hwy. 301 and the mouth of Tampa Bay during the field inspection.

Although no bird mortalities were observed, significant losses of fish and shellfish, the avian food base, were readily observed and documented. This loss of prey items provides a substantive basis for concern that the spill may have indirectly injured birds, in particular, by causing a loss of bird productivity for the 1998 breeding season, and diminishing future reproductive success and survival through the non-breeding season.

2) Lost Use of Fish for Recreation - Although preassessment information bearing on the potential for spill-related recreational fishing losses was limited, the fish kill caused by the spill was sufficient to indicate a potential for recreational fishing losses. Recreational fishing activity is linked to or affected by the availability and abundance of fish stocks. With the death of large numbers of fish, particularly recreationally important fish as were documented in this fish kill, there is a corresponding lost opportunity to use those fish for recreational fishing. Recreational fishing activity may decline or the quality of the recreational fishing experience may decrease as a result.

For each of these potential injuries, additional investigations or studies would have been necessary to assess and quantify the losses. For reasons explained later in this DARP/EA, the Agencies elected not to proceed with additional investigations or studies for these potential injuries. As an alternative, however, the Agencies sought to develop a restoration plan which would compensate for the documented natural resource injuries while also maximizing benefits to birds and recreational fishing. This strategy recognized that restoration actions available to compensate for documented injuries are likely, de facto, to effectively also compensate for any recreational fishing losses or indirect injuries to birds that may have occurred, based on the circumstances of the event and the period for exposure or effects. Accordingly, these potential injuries were considered in developing this DARP/EA.

2.6 Natural Resources With No Documented Injuries

As part of the preassessment process, the Agencies also considered the potential for the following additional injuries to natural resources or resource services, with the following results:

1) Estuarine Benthic Invertebrates - The Agencies compared pre- and post-spill sampling data bearing on the abundance and diversity of benthic communities in estuarine portions of the river. Unlike the comparisons for freshwater areas, however, the results here were inconclusive as differences in pre- and post-spill data were generally consistent with “normal” seasonal variability or salinity changes following significant rainfall, like that occurring in December 1997 before the post-spill sampling. With inconclusive preliminary data, the Agencies believed further study of potential injuries to estuarine benthos was not justified. This judgment also recognized that ecological benefits

to estuarine benthos would accrue from the types of restoration actions which would be considered to compensate for other injuries, such as for the fish losses.

2) Lost Use of Surface Waters for Recreational Boating - The Agencies conducted a preliminary assessment of potential recreational boating losses in the Alafia River. Based on the available data, the Agencies were unable to reliably identify any recreational boating losses which could be attributable to the spill, largely due to the limited time frame within which spill-related boating losses could have occurred and the rainy conditions which existed during that same period. Weather conditions were sufficient alone to have resulted in decreased boating during much of the spill period. Although the Agencies could have obtained additional data through surveys, interviews, etc., implementation of these methodologies represented a significant further expense. Given that there was little potential for recreational boating losses attributable to the spill, the Agencies judged that further action or cost to assess such losses unwarranted.

3.0 ASSESSMENT PLAN FOR QUANTIFIED INJURY CATEGORIES

3.1 Freshwater Wetlands

3.1.1 Overview of Preassessment Activities and Findings

To assess potential effects on wetland vegetation in freshwater segments of the Alafia River, biologists from DEP's Bureau of Mine Reclamation (BOMR) conducted a ground reconnaissance on December 19, 1997 and a helicopter overflight on December 23. Their ground reconnaissance covered from Lithia Springs upstream to the spill site in Mulberry. BOMR biologists found little evidence of injury to vegetation at Lithia Springs and Alderman Ford Park in Hillsborough County. Therefore, the assessment focused on impacted areas in Polk County. Injury to freshwater vegetation, notably die-off, was apparent in the vicinity of the bridge on Nichols Road, indicating that adverse effects could extend as far as ten miles downstream from the spill site. The helicopter overflight confirmed that observable vegetative losses did not extend beyond the Keysville bridge. During the overflight, BOMR biologists also discovered that the spill had overflowed river banks into surrounding floodplains.

Following this preliminary work, BOMR biologists undertook activities to document the size of the areas showing injury, the composition of vegetation in those areas, and the nature of the losses which occurred. This work (Williges et al., 1998) had two primary components - remote sensing to estimate the total acres of injured vegetation, and systematic field sampling to provide information on species composition, abundance, and percent cover within the injured areas.

<u>Remote</u> <u>Sensing</u>: An aerial photographic survey of the Alafia River, from its mouth at Tampa Bay to State Road 37 (near Mulberry), was conducted on January 31, 1998. The survey was completed on February 17, 1998, in an overflight covering Skinned Sapling Creek. The survey produced both true color and infrared false color 10" by 10" prints (scale 10" = 400'). Injured areas were delineated by tracing the distinctive green or gray-white areas, the signature colors for unhealthy vegetation, on transparencies overlaid upon the prints. Areas delineated using plant signatures on the infrared prints were cross-checked with areas delineated on the true color prints. A digital planimeter was used to calculate the area of the traced signatures. The average of three planimeter tracings was used to derive an acre estimate of injured vegetation.

As delineated by this method, the area of injured vegetation totaled 377 acres. All injured acres were located in Polk County. The total acres of vegetation losses reflected two primary areas of injury - 227 acres between the spill site and Skinned Sapling Creek, and 150 acres of vegetation affected downstream near Nichols bridge. Wetlands vegetation at both sites included primrose willow, cattail, elderberry, and dog-fennel.

<u>Systematic</u> <u>Field</u> <u>Sampling</u>: BOMR engaged in systematic field sampling between January 26, 1998 and March 5, 1998 to characterize vegetation in the areas injured, including species

abundance and cover. A systematic sampling approach, i.e., where stations were placed approximately an equal distance apart, was used; true random sampling or stratified random sampling was not possible**,** as many portions of the river were either impenetrable or not accessed efficiently. Twelve sampling stations, stations 1 – 12, were established between Keysville bridge and Skinned Sapling Creek. Stations 13 and 14 were established on Skinned Sapling Creek upstream from the North Prong confluence. Three control sites were established on non-impacted portions of the river: station 15 on English Creek, a tributary of the North Prong; station 16 on the North Prong but upstream from Skinned Sapling Creek and south of the confluence of Skinned Sapling Creek and the North Prong; and station 17 was on the South Prong. Stations 10 – 13 were located within the 227-acre area of impact. Stations 5 – 7 fell within the 150-acre area. Although vegetative damage at some downstream stations was not expected, these sites were monitored for plant stress that was not readily apparent, but might manifest itself over time.

Plant species present at each station were identified and stratified by cover classification. The categories were ground cover, shrubs, woody vines, subcanopy, and canopy. The mean cover (percent of sample area) dead and alive was visually estimated for each species within a cover category. The methods were modified from work done by others and summarized in Kent and Coker (1992). In addition, a species diversity index, the Shannon-Wiener index, was calculated for each cover class at all stations.

3.1.2 Determination of Injury

The Agencies have determined that substantial areas of wetland vegetation were exposed to acidic surface waters as a result of the spill and experienced a readily observable die-off as a result. Pre-spill, these freshwater wetland areas were largely populated by species such as primrose willow and cattail. Although often considered invasive or nuisance plants, these species still function to provide ecological services, including habitat for fish and wildlife and nutrient uptake and surface water improvement. These areas also provide some degree of biological diversity in the ecosystem. The loss of such vegetative services due to the die-off will continue until vegetation regrows to pre-spill levels. The reduction in vegetation resources and/or services due to the immediate die-off and the continuation of those losses, through time, until vegetative regrowth to pre-spill levels, comprises the full injury to freshwater wetlands caused by the spill.

3.1.3 Assessment Method

The BOMR report (Williges et al., 1998) on vegetative impacts provides the basis for the injury assessment. Data and other information within that report provide a reasonable estimate of the acres of wetland vegetation injured by the spill and are, for the most part, adequate to characterize the types of vegetative resources and services lost, consistent with assessment needs.

To complete the assessment of injury to freshwater vegetation, the Agencies plan to use a Habitat Equivalency Analysis (HEA). HEA is a methodology that facilitates a restoration-based approach to defining compensation for natural resource losses, as it estimates the acres of habitat required to functionally replace ecological service losses, according to a technically-structured formula. HEA is appropriate for use where service losses are primarily ecological and the creation of habitats or services like those injured or lost is technically feasible. The BOMR work provides data and other information that can be used to support application of a HEA to complete the quantification of vegetative services losses and to estimate the corresponding scale of replacement acreage.

The Agencies considered a number of functions provided by the lost vegetation, including nutrient uptake, habitat, and habitat diversity, in order to quantify vegetative service losses within a HEA framework. The vegetated cover dead (as a percentage of total cover) was used to approximate the injuries to these functions.

The injury area consisted of five classes of vegetation – ground cover, shrubs, woody vines, subcanopy, and canopy. The Agencies separated the classes into three groups – one comprised of the first three classes referred to collectively as “ground cover”, and the other two comprised of the subcanopy and canopy classes. Subcanopy species are those that are less than four inches in diameter at breast height, which also includes canopy willow species. The canopy class only includes mature hardwood species.

The area of total impact, as estimated by the 1998 BOMR report, was 377 acres; 227 acres – Area A – were impacted near Mulberry at Highway 37, and 150 acres – Area B – were impacted near the Agrifos property downstream of Nichols Bridge. Based on fieldwork by BOMR staff, the Agencies estimated the area of injury to ground cover, subcanopy, and canopy in injury Areas A and B. Of the 227 acres of impact in Area A, 185.5 acres were ground cover, 34.25 acres included subcanopy, and 7.25 acres were mature hardwoods (or canopy). The 150 acre area – Area B – included impacts to 129.8 acres of ground cover vegetation, 19.5 acres of subcanopy vegetation, and 0.7 acres of mature hardwoods.

The injury will be calculated for ground cover, subcanopy, and canopy in Area A and Area B. The measure of injury is the average dead cover (as a percent of total cover) in each area and vegetation class. Within the HEA framework, lost vegetation would be quantified in acre-year units, where an acre-year is the flow of vegetation services from an acre of vegetation in one year.

The HEA methodology also takes into account the time it takes injured habitats to recover and created or restored habitats to reach full maturity. BOMR undertook limited field work early in 1999 to help assess the injury to vegetation and its recovery over time. Based on this information, scientific literature, technical expertise and judgment, the Agencies expect the injured ground cover to return to pre-spill conditions in two years, with recovery beginning in

1998 and assumed to follow a linear path. The subcanopy injuries (includes impacts to all willow species) are expected to recover in five years, with recovery beginning in 1998 and assumed to follow a linear path. The canopy injuries, which are injuries to the mature hardwoods, are expected to recover in twenty years, also with recovery beginning in 1998 and following a linear path.

3.2 Fish, Crab, and Shrimp

3.2.1 Overview of Preassessment Activities and Findings

Preassessment data gathering focused on the instantaneous fish kill (including blue crab and pink shrimp) which resulted from exposure to the spill-induced acidity in the river. Biologists representing both the Agencies and MPI conducted sampling in the lower, tidally-influenced portion of the Alafia River December 11 through 14, 1997. These sampling efforts were initiated to collect ephemeral data necessary to estimate the magnitude and extent of the fish kill. All sampling efforts were conducted within the tidally-influenced portion of the river, from the mouth of the river to river km ~16. Three types of data were collected: (1) smaller animal seine and trawl data, (2) larger animal visual survey data, and (3) larger animal clean-up data.

<u>Seine and Trawl Sampling</u>: Smaller animal data was collected by DEP's Florida Marine Research Institute, Fisheries-Independent Monitoring Program (DEP/FIM) using methods consistent with an existing seine and trawl sampling program. That program has historically used small-mesh seines and trawl data to assess juvenile populations of larger species and juvenile-to-adult populations of smaller species (< 8 cm total length), and is a source of historic data on small animal species composition and abundance in the Alafia River.

DEP/FIM implemented supplementary sampling on December 12, 1997 after the plume of low pH passed through river segments 1 through 4, segments historically sampled in the DEP monitoring program. A stratified random sampling design was used for sample site selection. The seine stratum included shoreline areas with water depths less than 1.8 m, assumed to be representative of the shoreline community. The trawl stratum included non-shoreline areas with water depths greater than 1.0 meter, assumed to be representative of the river channel community. All fish were identified to the lowest practical taxonomic level and counted, and representative length frequencies were recorded. DEP/FIM's regular monthly sampling in these same segments resumed the week of December 17, 1997.

<u>Visual Surveys</u>: Larger animal visual surveys were used to collect data on larger animal (>8 cm total length) mortalities. These surveys sampled floating and beached specimens in the tidally-influenced segments of the river following the American Fisheries Society (AFS) visual survey protocols (AFS 1992) for the estimation of fish kills. In these surveys, dead fish observed in randomly selected areas are counted and measured; these counts are then expanded over the entire affected area to provide an estimate of the total number of large dead fish present in the

study area. In this assessment, the lower Alafia was divided into 6 segments, and each segment was divided into countable units, or transects. A total of 40 transects were counted in the lower portion of the river. Expansion factors were derived from the area covered by the surveyors in a given river segment, relative to the total area in that segment. The visual surveys were conducted by DEP/FIM, Mote Environmental Services (Mote) under contract to NOAA, FGFC, as well as Langford Aquatics and Environmental Services and Permitting, Inc. (ESP) under contract to MPI. All visual surveys counts were conducted between December 11 and 14, 1997, near the time the low pH plume passed through the study area.

Larger Animal Clean-up Data: Larger animal clean-up data was provided by FGFC based on their examination of the dead fish removed from the river by Southern Waste Services, Inc. (SWS), under contract to MPI. The total weight of all dead fish removed from the river by SWS was documented; data on species composition, numbers, length frequencies and average weight was also recorded by FGFC for a subsample of the dead fish.

The data from these three preassessment activities were compiled and used by DEP's FMRI to estimate mortalities for both smaller and larger animals. The data and the methods used by FMRI to generate those estimates are presented in detail in a report entitled "Assessment of Fish, Blue Crab, and Pink Shrimp Mortality in the Tidal Portion of the Alafia River Following the December 1997 Process Water Spill" (December 10, 1998). Those estimates are:

Larger fish killed - 72,900

Smaller fish and shellfish killed - 1,244,800 (mean)

The estimate of larger fish killed is the sum of two estimates - (1) the number of dead fish present in the surveyed portion of the river, as calculated using the visual survey data following AFS methods for estimating fish kills, plus (2) the number of additional dead fish removed from the river by SWS, as calculated using the larger fish clean-up data provided by FGFC. These estimates were 57,900 and 15,000, respectively.

The estimate of smaller fish, blue crab and pink shrimp killed was derived from consideration of the seine and trawl data on smaller animals, using an "observed mortality method". This method estimates the population of dead animals in the lower portion of the river sampled, based on data gathered from seine and trawl data on December 12, and is calculated as the number of each species collected per area sampled (e.g., catch per unit effort reported as number/m^2). The mean population estimate for dead animals (following stratified random sampling) was then calculated following Snedecor and Cochran (1967). Lower and upper mortality estimates for the observed mortality method were calculated by either subtracting (for lower estimate) or adding (for upper estimate) the standard error to the mean dead-animal population estimates. Lower, mean and upper dead animal population estimates were multiplied by the total area of the segments used in the analysis to estimate the total number of small dead animals in the lower portion of the river. The data and the methods used by FMRI to calculate these estimates are presented in detail in the DEP/FMRI report dated December 10, 1998.

The DEP/FMRI report includes preliminary post spill analysis (January and February 1998) from FIM's regular monthly seine and trawl sampling bearing on the recovery of small and juvenile species in the river. Some recovery was evident by January-February 1998, but the populations of numerically dominant and ecologically important planktivores (small schooling plankton-feeding fish), such as bay anchovies, remained depressed. Although interpretation of recovery patterns for some species was complicated by interannual differences in abundance, most species normally abundant in January-February appeared to be at normal or near-normal numbers, and other species which normally recruit during that period were present in large numbers.

3.2.2 Early Restoration Action

In April 1998, the Agencies were notified by DEP of the availability of a limited number of juvenile snook suitable for potential release into the Alafia River. The fish had been spawned at the DEP's Stock Enhancement Research Facility from brood stock captured in the Alafia River. The fish were part of a growth and nutrition study at Harbor Branch Oceanographic Institute Inc. in Fort Pierce, Florida and became eligible for release when the study ended. Applicable DEP policy required that the fish be returned to their waters of origin, however, funding necessary to return the fish to the Alafia River had not been identified.

The Agencies considered whether to approve and fund the release of these fish into the Alafia River as an early restoration action to address the impacts of the spill. The Agencies approved this early action after weighing many factors, including the relationship of the proposed action to injuries to fish caused by this spill, restoration objectives for fishery losses, the feasibility and cost of the proposal, and the importance of snook as a recreational fish. The fish had an average length of greater than 10", a preferable size for release because larger fish generally have increased survival rates. Snook of similar size were among those killed by the spill. Therefore, the release of these fish represented a feasible, direct replacement of snook, capable of partially offsetting the spill's kill of similar-sized fish. The early release of these snook also represented an opportunity for additional future fish production, which the Agencies believed could assist in reducing the future production losses attributable to the fish kill. The proposal could also be implemented at very little cost.

Following approval by the Agencies, DEP assumed the cost of implementing this early, primary restoration action, i.e., the cost of transporting, acclimating, and releasing these fish back into the Alafia River, as part of the restoration plan for this incident. The action was implemented on May 22, 1998 after the fish passed a health certification and were tagged. A total of 154 snook averaging 11" inches in length were released into the Alafia River at six different locations between the I-75 bridge and the mouth of the river and six locations east of the I-75 bridge.

3.2.3 Determination of Injury

Significant numbers of both large and small fish species, blue crab and pink shrimp died as a result of direct exposure to spill-induced acidity in the surface waters of the river. Of the species killed, bay anchovy, menidia, hogchoker and sand seatrout comprised approximately 95% of the smaller fish and juvenile adult species, and striped mojarra, gar, sheepshead, and hardhead catfish comprised about 70% of the larger fish species. Other economically important species, such as bullhead catfish, red drum, blue crab, sunfish, pink shrimp, and common snook, were also killed. The future biological production of the animals killed is also lost. The injury to fish, blue crab and pink shrimp is defined by both the immediate loss of animals directly killed by the spill and the interim loss of the biological productivity of those dead animals. The lost opportunity to use these fish for recreational fishing is considered later in Section 4.2.

3.2.4 Assessment Method

The DEP/FMRI report on fish, blue crab, and pink shrimp injury provides the basis for an assessment of direct mortalities documented in the tidally-influenced portion of the Alafia River. This report received extensive review by the Agencies and by MPI prior to its finalization. MPI in particular was very critical of data and methods used to produce the estimates and of the reliability of the resulting estimates. In response to MPI's comments, the Agencies conducted a thorough review of the data and methods used in the report. Based on that review, some changes were incorporated in the final report but, in the end, the Agencies disagree with MPI that the techniques used by FMRI to estimate these fishery losses were substantially flawed or resulted in estimates that were unusable for damage assessment purposes. Accordingly, estimates of the direct fish kill contained in the FMRI report are being utilized in this assessment.

The loss of future production and recruitment associated with the estimates of the direct kill are unlikely to be large enough to significantly alter future populations in the river, given the nature of this riverine environment. The Agencies believe that production from unaffected organisms and recruitment from unimpacted tributaries, upstream areas, and Tampa Bay will provide sufficient egg and young production to sustain populations of fish injured by the spill. Under these circumstances, further studies to assess an impairment of reproductive capacity are not required. The loss of future productivity associated with the estimates of direct kill can be calculated based on information contained in the biological database in the CERCLA type A model, Natural Resource Damage Assessment Model for Coastal and Marine Environments (NRDAM/CME, Version 2.5, French, et. al. 1996), other information augmenting the database for species killed by this spill, and the population model component in the NRDAM/CME model to predict the duration of such losses. Under this approach, the total kill estimated for each species, the size of those animals, and natural and fishing mortality estimates are used to define the numbers killed by age class and species, and the NRDAM/CME computes the normal production (as net somatic growth) expected from the killed organisms, and sums those losses over predicted life spans. Losses in future years are discounted 3% annually to yield a total estimate for the interim losses in present value terms.

To complete the assessment, the direct kill and the foregone production will be quantified as the total biomass lost. Total biomass lost can be calculated using the number of fish killed by age class and species (as gathered during the preassessment phase), standard fisheries equations of length versus age and weight versus length, and survival, mortality and growth rate determinations. This approach facilitates restoration planning as, using HEA, restoration can be scaled to replace the total biomass lost due to the spill.

The number of snook released in the early restoration action must be subtracted from the number of similar-sized snook included in the larger fish kill estimate before performing the above future production loss and total biomass calculations. This is necessary to ensure that, in calculating the biomass which will be used to scale restoration, neither the fish restored to the river nor future production associated with those fish are included. This step avoids overcompensating for remaining fish losses in scaling further restoration actions in this assessment process.

Although this assessment approach relies on NRDAM/CME's predictions to assess the duration of fishery losses, DEP/FIM's regular sampling of the estuarine portion under its historic sampling program has continued and is an ongoing source of information for use in monitoring the recovery of small species populations and juvenile populations of larger species post-spill.

3.3 Surface Water

3.3.1 Overview of Preassessment Activities and Findings

Data collection efforts to assess and monitor the spill's immediate effects on surface water quality in the Alafia River began the day after the spill, December 8, 1997 and continued until December 18, 1997. Water quality data was collected by EPC, FDEP, EPA, NOAA and MPI. Surface water samples were collected from a variety of stations by boat and from bridges. Samples were collected and results compared to historic long-term water quality data collected by EPC from five (5) sampling stations along the Alafia River. EPC measures approximately 35 water quality parameters as part of their established long-term monitoring program, including for pH, phosphorus and nitrogen. EPC has presented their data and other information used to evaluate surface waters impacts during the preassessment phase in the report entitled "Mulberry Phosphates Inc. - December 1997 Acid Spill, Water Quality Impacts on Alafia River and Tampa Bay, May 29, 1998".

Monitoring for pH: Monitoring for pH occurred at fourteen (14) stations along the river. Samples were taken starting on the day of the spill, December 7, 1997, and continued for the next eleven days until December 18, 1997. The station locations and numbers, dates of sampling, detected pH levels, and collecting agency are presented in Appendix B.

As the data in Appendix B shows, on December 8, the day after the spill, surface water samples had a pH of 2.8 at the Keysville Bridge location and of 7.2 at Alderman Ford Park (usual pH at these locations is about 7.2 - 7.4). On December 9, surface water pH was found to be at or below 3.1 from the Keysville Bridge downstream to Bell Shoals. The pH at Hwy. 301 was considered normal, a 7.6, that day. On December 10, surface water pH was below 4.0 from Alderman Ford Park downstream to Hwy. 301. As of December 11, approximately 27 miles of the river had surface waters with a pH less than 6.0. Except for the section of river upstream of Nichols Bridge, pH measurements in the Alafia River had returned to levels above 6.0 by December 16, 1997. However, a few sampling stations near the site of the spill, at the Highway 37 bridge in the City of Mulberry and at Nichols Bridge, continued to have pH levels below 6.0 through December 19, 1997. Preassessment sampling efforts by the Agencies ended on January 7, 1998.

The above pH data also show the progress of the released process water as it moved downstream in the Alafia River as a plume. By December 15, the plume had reached the mouth of the Alafia and entered Tampa Bay, where the higher alkalinity of bay waters would have neutralized any remaining acidity.

Monitoring for Nitrogen and Phosphorus: In addition to abnormally low pH levels, EPC found extremely high concentrations of nitrogen and phosphorus in the river and in Tampa Bay following the spill. This is based on analysis of EPC's 24 year database from routine monitoring of surface water quality in both the Alafia River and Tampa Bay. During the spill event, nitrogen reached a maximum concentration of 46.26 mg/l in the river, compared to a previous 3 year recorded high of 3.23 mg/l. Similarly, during the spill event, phosphorus in the Alafia reached a maximum concentration of 234.83mg/l, whereas, in the 3 years prior to the spill the highest recorded phosphorus concentration was 24.86 mg/l.

The Tampa Bay Estuary program has researched and documented the role of nitrogen in the health of Tampa Bay (TBEP 1996) and has established goals for limiting nitrogen loading. Nitrogen in small amounts is a nutrient but in high concentrations is responsible for producing excessive algal growth, reducing oxygen and light levels in the Tampa Bay. High populations of algae or phytoplankton reduces sunlight penetration in the water column which is essential to maintenance and growth of submerged aquatic vegetation, such as sea-grasses. Although phosphorus is also a nutrient for algal growth, nitrogen is considered the limiting or controlling nutrient in Tampa Bay.

On June 18, 1998 the EPA, acting under the Clean Water Act, approved the DEP's proposed Total Maximum Daily Loads (TMDLs) for nitrogen in Old Tampa Bay, Hillsborough Bay, Middle Tampa Bay, and Lower Tampa Bay based on work conducted for the Tampa Bay Estuary Program (EPA, 1998) (Zarbock et al., 1994, Janicki et al., 1996, Zarbock, et al., 1996a, Zarbock, et al., 1996b). The TMDLs for nitrogen were identified to maintain all applicable state water quality standards. For Hillsborough Bay, into which the Alafia River discharges, the TMDL was approved at 7951 lbs/day or 1451 tons per year (EPA, 1998). The nitrogen released during the spill as a single discharge, 656775 lbs. or 328.4 tons, is approximately 22.6% of the approved yearly TMDL for Hillsborough Bay (1451 tons) or nearly 11% of all the approved yearly TMDLs for Tampa Bay (3085 tons).

In the first four months following the spill (January, February, March and April 1998), levels of Chlorophyll *a*, an indirect measure of microscopic algae present in the water column, revealed the presence of atypical concentrations of microscopic algae in the Alafia River and Tampa Bay, compared to monthly averages over the last 24 years. These concentrations were reported when levels are historically the lowest (Cardinale, 1998) Chlorophyll *a* concentrations began to return to normal levels in May, 1998. These data indicate the spill caused or significantly contributed to an imbalance in the natural populations of aquatic flora in the Alafia River and Tampa Bay.

3.3.2 Determination of Injury

The spill changed the physical and chemical quality of the surface waters of the Alafia River and Tampa Bay. The release of the acidic process water resulted in acidity, measured as standard units of pH below 7.0, in the river. Measured pH levels in the river fell well below levels allowable under Florida law. The applicable state water quality criterion for pH is established by Florida Administrative Code (F.A.C.), Rule 62.302.53052)(c), which provides that pH shall not vary more than one unit above or below natural background and, in no case, be depressed below 6.0 units. Data collected during the spill event show that surface water pH in the Alafia River fell below 6.0 for up to eleven (11) days as a result of the spill. Further, the spill-induced acidity in the river was sufficient to cause acute injuries to other natural resources upon exposure and, in fact, injured wetland vegetation, as discussed in Section 3.1, and caused an instantaneous kill of fish, blue crab, and pink shrimp in the river, as discussed in Section 3.2.

The spill also caused or contributed to an imbalance in the natural populations of aquatic flora in Alafia River and Tampa Bay, contrary to F.A.C. Rule 62-302.530(48)(b), by adding large amounts of phosphorus and nitrogen to the estuary. Evidence indicates these additions altered nutrient concentrations in that system and caused or contributed to a documented imbalance in algae concentrations within the Alafia River and Tampa Bay.

3.3.3 Assessment Method

The EPC report on water quality impacts provides the basis for the injury assessment. The report contains the relevant sampling data for both the Alafia River and Tampa Bay. All monitoring data can be found in Appendix 4-A of the EPC report.

The data identified in the report is sufficient to quantify the injury to surface water based on the alteration of pH. The nature and extent of the effect on pH and its relationship to the documented fish kill are identifiable from existing data. Available pH data also provides the basis for characterizing the recovery of surface waters from the spill-induced acidity as pH levels were showing improvement in most areas of the river by December 12, 1997. Further, the higher alkalinity in Tampa Bay would have facilitated recovery by acting to neutralize or buffer acidity in surface waters exiting the river, likely in a very short time.

The data identified in the report is also sufficient to characterize the nature and extent of the imbalance in aquatic flora resulting from the spill. This injury can be characterized in terms of the increased nutrient loading into the ecosystem attributable to the spill, using nitrogen as a metric. This approach will facilitate restoration planning as restoration actions can be scaled to offset this loading based on their ability to remove nitrogen from surface water over a project's lifespan. The approach is cost-effective as it can be implemented using available information, avoiding the need for complex or prolonged field studies to further quantify the temporal and spatial faunal imbalance caused by the release. Further, this approach scales the restoration for MPI's nitrogen contribution only, which avoids including any other unauthorized inputs of nitrogen that occurred at or near the time of the spill.

In assessing compensation for MPI's release, calculation of the amount of nitrogen from the spill is fairly simple and straightforward, based on the following formula[1]:

Loading in pounds = (millions of gallons spilled)(mg/l of contaminant)(8.342)

Table 1 shows the nitrogen constituents and concentrations of typical process water and the estimates the total mass of nitrogen released. The Agencies used 50 million gallons as a conservative estimate to calculate the total loading in pounds.

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[1] The formula includes a conversion factor of 8.342 that converts concentration (mg/l) to pounds (lb) when volume is in millions of gallons (gal) i.e., 8.342 = (3.785 l/gal) * (2.204 x 10^{-6} mg/lb) * (1,000,000gal)

Table 1

Parameter*	Range (mg/l)*	Average	Estimated Loading in Pounds	Estimated Loading in Tons (short)
O-PO4 as P	6000 to 10000	8000	3336800	1668.4
Ammonia as N	1000 to 2000	1500	625650	312.8
Organic N as N	50 to 100	75	31283	15.6
Total N			6569323	328.4

*** Composition of typical process water from DEP list of 46 parameters**

Data from EPC's ongoing water quality monitoring program may be used to assess surface water recovery from this adverse condition. Relevant data from that program for January through May 1998 is noted in the EPC report and indicates Chlorophyll *a* concentrations were nearing normal levels in Tampa Bay by May of 1998, a preliminary indication of recovery. Data from EPC's ongoing monitoring program can be used to assess the duration of the injury and when recovery is complete.

3.4 Benthic Invertebrates

3.4.1 Overview of Preassessment Activities and Findings

EPC and DEP biologists conducted a preliminary investigation of the effects of the acid spill on the benthos of the Alafia River. Biological and chemical samples at stations in both the freshwater and estuarine portions of the river were collected December 17 to 19, 1997. DEP biologists focused on the potential for injury to benthos in the freshwater portion of the river. Their investigative strategy involved data collection necessary to allow comparisons of benthic abundance, diversity and community structure between spill-exposed and background/reference stations, with concurrent consideration of data on the physiochemical character of the overlying surface waters of the river.

A total of 7 stations were used in the field sampling, 5 potentially impacted sites and 2 background/reference stations. All stations were located in the Alafia River in eastern Polk and western Hillsborough counties, with the furthest downstream station being near the Keysville Bridge. At all 7, surface water samples were taken and analyzed for relevant physiochemical parameters, such as pH, dissolved oxygen, temperature, conductivity, total suspended and dissolved solids, fluoride, nitrogen, phosphorous, and five metals (aluminum, sodium, calcium, magnesium and potassium). At 4 of these stations (2 potentially impacted, 1 reference, and 1 background), relevant biological data was also collected, including total taxa, density/m, the

Shannon-Wiener Diversity Index[2], presence of EPT organisms[3], and on the presence of environmentally sensitive invertebrates designated by the Florida Index[4] (FI). Benthic community data for 3 replicate samples were combined at one of the potentially impacted stations.

EPC evaluated the potential for injury to freshwater benthos attributable to the spill by comparing the physiochemical data for overlying surface waters with information on the associated benthic abundance and community structure (Grabe, 1997). That data evaluation indicated that both benthic species abundance and diversity were reduced at stations downstream from the site of the release relative to reference and background stations. Despite differences between habitats at reference/background stations and stations sampled downstream, concurrent consideration of the surface water and biological data suggest the reduced abundance and diversity of freshwater benthos at spill-exposed stations are attributable to the spill, i.e, resulting from direct toxicity from the low pH waters, from toxicity associated with high levels of trace metals in the released process waters, or from toxicity associated with high levels of trace metals released from sediments following the interaction of sediments with the acidic process water. This data and evaluation are presented in a report prepared by DEP entitled ECOSUMMARY, A Report by the Surface Water Assessment and Monitoring Program (SWAMP), #98-002 (DEP, 1998).

3.4.2 Determination of Injury

Freshwater benthic communities exposed to the released process waters downstream of the spill site exhibited reduced abundance and species diversity 10 to 12 days following the spill. The injury to freshwater benthic resources includes both direct injuries attributable to spill-related toxicity as well as the reduction in benthic resource service as a food base for higher trophic levels. The injury persists until direct toxicity ceases and recruitment and recolonization returns the benthic community structure and function to pre-spill levels.

3.4.3 Assessment Method

Although DEP's preassessment data and evaluation indicate an injury to freshwater benthic communities occurred, additional information would be needed to fully quantify the injury and complete an assessment sufficient to support active restoration planning. This would

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[2] Please refer to section 3.1.3 of this DARP/EA for description of the Shannon-Wiener Diversity Index.

[3] Refers to Ephemeroptera, Plecoptera and Trichoptera; i.e. mayflies, stoneflies and caddisflies.

[4] The Florida Index is a tolerance measure: The weighted sum of intolerant taxa, which are classified as 1 (least tolerant) or 2 (tolerant). FI = 2*(# class 1 taxa) + 1*(# class 2 taxa).

include information on the types of benthic resources lost, the areal extent of losses, the magnitude of losses, the duration of the losses, and the form of their recovery.

A number of factors led the Agencies to conclude that further investigations to address these information needs were unwarranted. First, changes in benthic community structure in response to short-term changes in environmental conditions are often of short duration, as benthic recolonization and recruitment can occur rapidly. The circumstances of this incident are consistent with expectations of rapid recovery, even with a view to a reasonable worst-case scenario for benthic injury. Adverse conditions caused by the spill would likely be of short duration and opportunities for species immigration from upstream and non-impacted tributaries existed. Data from a DEP post-spill sampling effort (DEP, 1998) indicated that the most sensitive benthic organisms in estuarine areas were reappearing as quickly as three weeks after the source of the aquatic toxicity ended. Further, the Agencies recognized that interpretations of further data would be confounded to some extent by normal variability in benthic data as well as by effects from notable rainfall in December after the spill which also altered salinity and flow conditions in the river. The expense of a further study was also a concern, given the probable marginal utility of any additional data.

The Agencies also considered likely restoration objectives for benthic injuries. Given the strong likelihood of a rapid recovery to pre-spill conditions, additional restoration to address primary injuries would not be needed. In-kind compensation for any short-term, interim loss of benthic functions would accrue as a result of restoration actions undertaken to restore or compensate for lost freshwater wetland services. Consequently, the Agencies determined that additional site-specific studies to provide more detailed information for use in the assessment of benthic injuries were not justified.

Because the Agencies determined further action to assess freshwater benthic invertebrates injuries was not justified, an injury-specific restoration plan for the loss of these resources is not included in this DARP/EA. However, the Agencies have sought to ensure that the restoration plan developed to compensate for other resource injuries in this DARP/EA is consistent with actions appropriate to address any interim losses of freshwater benthic invertebrates. This strategy is consistent with that adopted for Oyster and Mussel losses, described in Section 3.5, and potential bird injuries and recreational fishing losses, described in Sections 4.1 and 4.2, respectively.

3.5 Oysters and Mussels

3.5.1 Overview of Preassessment Activities and Findings

Visual observations, by EPC staff, of structures or shorelines in the estuarine portion of the river prior to the December 7, 1997 spill noted the presence of substantial populations of oysters and mussels. These populations were particularly abundant on structures and shoreline areas between Hwy. 41 and I-75. The total numbers and/or full areal extent of these biota, however, had not determined prior to the spill.

Two oyster habitat restoration projects had been implemented in the lower Alafia River prior to the spill. Both were undertaken as mitigation projects related to the Gardinier, Inc. (now Cargill Fertilizer, Inc.) phosphoric acid spill of May 1, 1988. The Alafia River Oyster Bar Restoration Demonstration Project was implemented in 1995. The Williams Park Pier Oyster Reef Project was a joint EPC/DEP effort built in 1996 to test the use of artificial substrate for the development and colonization of live oysters in the river. The locations of these reefs are noted in Figure 1. Since implementation, both projects have been the subject of periodic inspection and monitoring.

EPC inspected both reef sites following the spill (Cardinale, 1998). On January 14, 1998, EPC found no live oysters during a qualitative inspection of the Williams Park Pier oyster reef. A second, closer inspection of that reef on January 27, 1998 indicated some oysters had survived. On May 13, 1998, EPC conducted a quantitative inspection of that reef. Clusters of oysters from the reef areas under the pier were removed from their polyethylene tubes, sorted (live or dead), counted and the percentage of dead oysters estimated. Only oysters greater than about 1 inch were counted to ensure counts were limited to oysters which would have been present on the reef during the period of the spill (oysters under 1 inch may have recruited and developed after the spill). EPC estimated that over 33% of the oysters under the Williams Park pier were dead based on these counts. EPC did not note any oyster mortality in inspections of the Oyster Bar Project site (Ash & Cardinale, 1999).

On December 15, 1997, EPC staff observed that the mussels attached to the I-75 bridge pilings appeared to have been killed. Prior to the spill, these visible parts of the I-75 bridge pilings were densely populated with mussels.

The pH levels recorded during the spill event in the Alafia River, including at the Hwy 41 bridge, near the Williams Pier, and the effect of such low pH values on aquatic biota are previously described in this DARP/EA at Sections 3.1 and 3.2. This information is also part of the data used in evaluating the impact to oysters and mussels during the preassessment phase.

3.5.2 Determination of Injury

Both oyster and mussel mortalities were observed after the spill in areas of the lower Alafia River where acidic surface water conditions were documented and where exposure to acidic surface waters was acutely toxic to other aquatic species. Therefore, the evidence is sufficient to indicate the spill-induced acidity in the surface waters caused or contributed to observed mortalities of oysters and mussels. The presence of such mortalities at the Williams Park Pier reef site and on I-75 bridge pilings indicates that mortalities of oysters and mussels likely extended to populations at other locations upstream.

3.5.3 Assessment Method

Although available information indicates the spill caused or contributed to observed mortalities of oysters and mussels, that information is insufficient to quantify such losses. Pre-spill observations and monitoring at the reef project sites provided a basis for investigating the effect of the spill on oysters but offer only limited information bearing on the general baseline health and population of oyster communities in the Alafia River. Additional information would be needed to define the distribution and likely abundance of pre-spill populations in the river as a basis for estimating post-spill impacts and to further define post-spill mortalities.

For a number of reasons, the Agencies concluded further work to address these needs was not warranted in this instance. Oyster and mussel populations typically will recruit and recover fairly quickly from temporary adverse changes in environmental conditions. Short-term recovery scenarios complicate the task of implementing investigations post-event which will adequately define or quantify losses and are an indication that interim losses associated with these mortalities may be relatively small. In the case of oysters and mussels, too, the heavy rains in the region following the spill are also relevant to understanding observed mortalities as this rainfall lowered salinity in the river to levels that may also have been sufficient to result in oyster and mussel mortalities. Where losses may be of short duration and additional work may yield inconclusive results, the Agencies felt the cost of additional assessment work was difficult to justify.

Figure 1 Approximate Locations of Created Oyster Reefs in Lower Alafia River

Likely restoration objectives for oysters and mussels were also considered. Primary restoration actions were considered unnecessary because populations were expected to return to baseline levels within a relatively short period of time. Further, restoration actions for other resource injuries were considered likely to also compensate for any short-term losses of these resources. Consequently, the Agencies determined that additional studies to support further assessment of the interim losses of oysters and mussels was also not required to meet restoration objectives for any spill-related losses.

Because the Agencies have determined further action to assess oyster and mussel losses is not justified, an injury-specific restoration plan for oysters and mussels is not included in this DARP/EA. However, the Agencies have sought to ensure that the restoration plans developed to compensate for other resource injuries in this DARP/EA are also appropriate to address any interim losses of oysters and mussels. This strategy is consistent with that adopted for injuries to Freshwater Benthic Invertebrates, described in Section 3.4, and potential bird injuries and recreational fishing losses, described in Sections 4.1 and 4.2, respectively.

4.0 ASSESSMENT DETERMINATIONS FOR NON-QUANTIFIED INJURY CATEGORIES

4.1 Birds

4.1.1 Overview of Preassessment Activities and Findings

The FWS investigated the potential for spill-related injuries to bird species. The potential for injuries to migratory birds were a primary concern of these investigative activities. That investigation included a search of historical wildlife data, GIS database analysis, and consultation with DEP, FGFC and NAS personnel on species within or using the spill area and the potential for adverse effects. FWS biologists also conducted an inspection of the spill area in January 1998.

FWS confirmed that many bird species utilize the Alafia River corridor for nesting, feeding and/or resting. The list compiled by the FWS is presented in Table 2. These included migratory bird species such as raptors, seabirds, waterfowl, wading birds, and shorebirds. Over 25 avian species were witnessed using the area between U.S. Hwy. 301 and the mouth of Tampa Bay during the field inspection and the presence of several bird colonies in the Alafia river corridor, including nesting sites for the bald eagle and osprey, were identified from GIS data. Migratory bird rookeries known to be in the spill area were a focus of the FWS's investigation. Preliminary research by FWS staff found little available data from which to assess the baseline health and abundance of populations of birds in the spill area.

Table 2 Birds Confirmed by FWS Within The Alafia River Corridor

Double-crested cormorant	Red-breasted merganser	Tern spp.	Yellow-crowned night heron
Wood stork	Turkey vulture	Belted kingfisher	Red-shouldered hawk
Osprey	Least sandpiper	Foster's tern	Peeps (sandpipers, etc.)
Brown pelican	Lesser scaup	Little blue heron	Various gull species
Great egret	White pelican	Great blue heron	American oystercatcher
Snowy egret	Tricolored heron	Reddish egret	Northern shoveler
White ibis			

No bird mortalities were observed or otherwise reported to agencies involved in investigation of the spill. Further, the FWS found no obvious effects to threatened or endangered avian species. Significant losses of fish, crab, and shrimp were, however, readily observed and documented by other agencies and MPI during the event. (See Section 3.2, Fish, Crab, and Shrimp). The loss of fishery resources represented a loss to the forage base upon which migratory birds depend for survival, growth, and reproduction. The fish kill caused by this spill occurred just prior to the 1998 bird breeding season, which typically occurs between February and July. Together with information on the magnitude of the fish kill, this fact increased the prospects for injury to migratory bird populations through a loss of productivity during the 1998 breeding season. The FWS determined that additional studies, however, would be required to provide data necessary to confirm whether reproductive success was affected during the 1998 breeding season and to assess the nature and extent of resulting losses to migratory bird populations.

4.1.2 Assessment Determination

As noted above, preassessment investigations conducted by FWS indicated the potential for the spill to result in indirect injury to migratory birds. To confirm and quantify any such injury however, additional information would be required.

The FWS considered several strategies and methodologies for collecting appropriate data, including a study of nest abandonment rates for migratory species. In consulting with the NAS however, it was recognized that any decrease in nesting success identified in 1998 would be difficult to reliably attribute to the spill without study of other variables that may contribute to such losses. Such a study would be technically complex, add considerable cost, and take one to two years to complete. The opportunity for meaningful pre- and post-spill comparisons is also complicated by the limits of existing baseline data on avian populations along the Alafia river, increasing the chance that study results would be inconclusive. The additional time to complete the bird injury assessment would have greatly extended the time to complete the natural resource assessment for this spill event.

The FWS also considered the likely restoration objectives for birds, assuming losses of productivity occurred in 1998. A variety of restoration projects, such as surface water improvement or restoration of riverine habitat, would benefit migratory birds by increasing foraging success and accelerating recovery of populations to pre-spill conditions. Future reproduction can be enhanced through the creation or enhancement of habitats suitable for nesting migratory bird populations. Opportunities to benefit bird populations were inherent in restoration options available to address injuries to Freshwater Wetlands, Surface Waters and Fish, Crab, and Shrimp.

Because additional studies to assess bird injuries would be costly, potentially inconclusive, and greatly extend the time to complete the assessment process for this incident, and because restoration objectives for any bird injuries can be addressed through restoration actions to address other documented resource injuries, the FWS recommended no further studies to assess the potential injury to birds be undertaken. The Agencies concurred with that recommendation.

Since the Agencies determined further action to assess bird injuries was not justified, an injury-specific restoration plan for birds is not included in this DARP/EA. However, the Agencies have sought to ensure that the restoration plan developed to compensate for other resource injuries in this DARP/EA is also appropriate to address any potential interim injuries to birds. This strategy is similar to that which the Agencies adopted for injuries to Freshwater Benthic Invertebrates and Oysters and Mussels, described in Sections 3.4 and 3.5 respectively, and for potential recreational fishing losses, described in Section 4.2.

4.2 Recreational Fishing Losses

4.2.1 Overview of Preassessment Activities and Findings

Circumstances surrounding the spill, notably the surface water acidity, the resulting fish kill, and warnings reported in the news and posted at boating access points, suggested that recreational fishing activity could be adversely affected by reducing angler trips or by diminishing the value of trips taken due to reduced catch rates. NOAA's early activities focused on collecting data and information which could be used to assess whether spill-related recreational fishing losses occurred and, if so, to estimate those losses objectively. These efforts included a survey of bait and tackle shop owners along the Alafia River, consideration of data bearing on baseline fishing activity, and preliminary evaluations of this information.

NOAA contacted bait and tackle shop owners along the Alafia River to request information on sales receipts for months preceding and during the spill. Such information can be an indication of changes in levels of fishing activity. NOAA received records from some shop owners; others were unwilling to provide this information. Records received showed that reductions in bait sales of up to 70 percent did occur in December 1997, evidence that recreational fishing activity was, in fact, reduced during the spill period. The extent to which the spill event caused or contributed to the reduction could not isolated based on this information alone, however, as the Tampa Bay region experienced record levels of rainfall in December 1997, a circumstance that would also be expected to affect recreational fishing activity.

NOAA contacted many local and state resource management agencies and interest groups in an effort to locate data on baseline recreational fishing activity in the Alafia River. Two data sources were located. The FGFC, Division of Law Enforcement provided data, by month, on the number of recreational fishing boats (and other vessels by type) intercepted by its enforcement officers during patrols of the Alafia River from November 1997 through January 1998. An annual total for all vessel types and the number of hours patrolled for 1997 was also provided. The data for 1997 indicated that officers checked an average of 0.7 users per patrol hour and that roughly 30 percent of intercepted users were recreational fishermen. FMRI's Division of Marine Resources provided boat counts from a 1996 aerial survey of the Alafia River. That survey focused on the mouth of the river east to Interstate 75, an area representing about one-half of the estuarine part of the river. Overflights were conducted in two month waves, with three weekday and three weekend flights occurring per wave. For weekday flights, the highest number of recreational fishing boats reported was 9; the average was 2.6. For weekend flights, the highest number of boats was 4; the average was 1.4. This information provided a rough estimation of baseline recreational fishing levels.

NOAA also considered the Fish, Crab, and Shrimp injuries caused by the spill. These losses are relevant as recreational fishing is linked to and can be affected by changes in the availability and abundance of fish stocks. Where losses of fish occur, angler trips and the value of trips taken can be reduced because of reductions in catch rates. The greater the fishery losses, the greater the likelihood that such losses will occur. Several species of important recreational fish were killed as a result of this spill, including sheepshead, snook, and red drum. The investigations undertaken to document and estimate the Fish, Crab, and Shrimp injuries caused by the spill are described in Section 3.2. The nature and magnitude of the fish kill was considered sufficient to indicate a potential for recreational fishing losses.

4.2.2 Assessment Determination

Data available from preassessment activities were sufficient to indicate a potential for spill-related, recreational fishing losses, primarily as a result of the documented fish kill. The data, however, were insufficient to confirm or quantify such losses. Additional investigations would be required both to better define baseline recreational fishing activities in the river and to assess and quantify any reduction in trips or value of trips due to the spill.

Data of this nature can be obtained through systematic surveys and interviews, but such studies are expensive due to technical considerations applicable to the design and implementation of such work. Isolation of spill-related effects would be difficult for any losses just after the spill as the record rainfall in December 1997 remains as a confounding factor. The opportunity for losses related to the fish kill would continue until stocks recover but might also be difficult to isolate in such studies from other factors affecting fishing over the long term and would require more specific information on fish stock recovery. The additional cost of such studies is difficult to justify where results could be inconclusive or where required restoration or the value of the loss might not add substantially to the final claim.

As noted above, recreational fishing is linked to and can be affected by changes in the availability and abundance of fish stocks. Just as the number and value of angler trips can be reduced by a fish kill, restoration actions to increase production and replace lost fish can have a positive effect on the number and value of angler trips in the future. While available data is insufficient to complete an assessment of recreational fishing losses, that data can be used to assist in identifying restoration actions which are most likely to also compensate for potential recreational fishing losses.

For these reasons, the Agencies determined that additional site-specific studies to provide information for use to assess and quantify recreational fishing losses was not necessary and that the additional costs of those studies would not be justified.

Since the Agencies have determined further action to assess recreational fishing losses is not justified, an injury-specific restoration plan for recreational fishing is not included in this DARP/EA. However, because of the benefit of increased fish stock on catch rates and fish trip values, the Agencies expect the restoration actions identified to compensate for fish injuries - through increasing fish biomass - to also address the recreational fishing injuries. This strategy is similar to that which the Agencies adopted for injuries to Freshwater Benthic Invertebrates and Oysters and Mussels, as described in Sections 3.4 and 3.5, respectively, and for potential bird injuries in Section 4.1.

5.0 OVERVIEW OF ASSESSMENT AND RESTORATION PLAN

Sections 5.0 and 6.0 present the strategy, restoration alternatives and scaling methods which the Agencies have identified to use to provide for the restoration, rehabilitation, replacement or acquisition of natural resources or resource services to compensate for the natural resource injuries resulting from the spill.

5.1 Restoration Planning Strategy

State, federal and local liability frameworks for natural resource damages share a common objective -- to provide for expeditious restoration, replacement, or acquisition of equivalent resources or services when injuries to natural resources result from unauthorized discharges of hazardous substances, pollutants or contaminants. Under these laws, the Agencies are responsible for determining the actions needed to restore injured resources and lost resource services to baseline (termed 'primary restoration') and to compensate for interim losses (termed 'compensatory restoration'). The costs of implementing those actions represent a primary measure of an RP's natural resource damages liability.

Consistent with this legal and policy framework, the Agencies' strategy in developing this DARP/EA has been to define compensation for the natural resource injuries or losses which resulted from the spill based the restoration actions which are necessary or appropriate to return resources or services to baseline levels or to compensate for interim losses. Consideration of restoration actions favors the use of on-site, in-kind restoration approaches, wherever possible, to ensure the most direct relationship between resource injuries or service losses and the benefits of restoration actions. The choice of assessment methodologies outlined in this DARP/EA is consistent with this restoration-focus.

In restoration planning, the Agencies' emphasis has been on the areas or resources directly affected by the spill; however, the approach also takes into account the fact that the resources injured are part of a larger ecological system - the Alafia River basin watershed and the Tampa Bay estuary. In identifying and evaluating restoration alternatives, the Agencies have considered, where appropriate, the extent to which restoration actions offer multiple ecological or human use benefits to the larger ecosystem in addition to the benefits to a specific injured resource. Benefits to other resources injured or potentially injured as a result of this spill incident are taken into account under this approach.

Finally, the Agencies' strategy in developing this DARP/EA has also been to use simplified, cost-effective procedures and methods wherever feasible to document resource injuries and to define restoration-based compensation. Accordingly, depending on the injury category, the DARP/EA uses, alone or in combination, relevant scientific literature, scientifically-based models, and focused injury or quantification analyses. Throughout, the Agencies have endeavored to arrive at the most accurate estimate of the injuries caused by the spill, based on the best scientific information and most reliable methods available, at reasonable cost.

5.2 Framework for Identifying Preferred Restoration Alternatives

Restoration alternatives were identified through a two step process. First, a Restoration Workgroup comprised of representatives of the Agencies consulted with or contacted various agencies and private groups, such as SWFWMD, NAS and the Alafia River Basin Stewardship Council (ARBSC), to identify potential restoration alternatives. The Agencies also published a notice in the Tampa Tribune seeking input on restoration alternatives directly from the public.

Through these activities, the Agencies identified ten potential restoration alternatives. These ten alternatives are listed in Table 3 along with examples of potential projects that may be consistent with each alternative.

Table 3

Restoration Alternative	Generic Description and Examples of Potential Projects
Natural Recovery	Allow injuries to recover w/o human intervention • No Action
Enhancement via Nuisance Control	Eliminate nuisance or exotic vegetation from wetland habitats • Application of herbicides • Controlled burns • Mechanical removal of vegetation
Restoration of Estuarine Wetlands[5]	Create or restore wetlands in estuarine areas of the Alafia River • Saltmarsh restoration • Seagrass restoration • Mangrove restoration • Open water habitat creation
Fish Stocking	Rear and release recreationally or commercially important fish species • Freshwater fish stocking • Estuarine fish stocking
Restoration of Riverine Habitat	Create or restore wetlands in freshwater areas of the Alafia River • Freshwater marsh restoration • Emergent and submergent vegetation restoration • Floodplain habitat creation or restoration
Land Acquisition	Acquire environmentally sensitive land for public use or benefit • Fee simple purchase of environmentally sensitive land • Purchase of conservation easements

[5] This alternative is labeled or referred to as 'Restoration of Low Salinity Habitat' in agency records from this screening period.

Surface Water Improvement Projects	Any project that will improve the quality of surface water entering the Alafia River watershed. • Stormwater retention/detention systems • Site specific pollution abatement projects • Construction of filter marshes • Removal of agricultural lands from production • Creation of wetland buffer areas
Stream Enhancement Projects	Projects that improve existing freshwater stream habitats • Stream channel modifications • Bank stabilization projects
Recreational Projects	Projects that increase or improve public recreational opportunity on the Alafia River • Boat ramps • Build canoe rest stops launches • Repair/recondition recreational facilities (i.e., shelters, benches, picnic areas) • Boardwalks and nature trails
Reef Creation[6]	Projects that create underwater, intertidal or shoreline habitat that directly benefit fish and/or invertebrates • Create/restore oyster reefs • Deploy Reefballs™ • Deploy freshwater snags

All restoration alternatives were then screened by the Agencies based on the restoration criteria outlined below at 5.2.1. A primary consideration in this initial screening process was the relationship of the alternative and its potential benefits to the natural resource injuries that occurred due to this spill event. This initial screening resulted in the identification of five restoration alternatives that, in the judgment of the Agencies, could reasonably be expected to achieve objectives for the restoration of injured resources, in light of all the criteria to be applied: Restoration of Riverine Habitat, Restoration of Estuarine Wetlands, Reef Creation, Land Acquisition, and Surface Water Improvement Projects.

These alternatives were then considered more carefully by the Agencies based on the criteria outlined below. These alternatives and the results of that evaluation, with preferred restoration alternatives identified, were presented for public review and comment in Section 6.0 of the Draft DARP/EA released on July 22, 1999. Section 6.0 of this DARP/EA presents the Agencies' final evaluation and selection of restoration alternatives. Additional information on the screening process is presented below at 5.3.

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[6] This alternative is labeled or referred to as 'Artificial Reef' in some agency records from this screening period, but encompassed potential restoration or creation of oyster reefs.

5.2.1 Selection Criteria

The following criteria have been used by the Agencies to screen and to evaluate the listed restoration alternatives:

Relationship of Restoration Action to Type and Quality of Resources and/or Services Injured - Considers the nature and extent to which a restoration action would address the natural resource injuries that occurred as the result of the spill. This includes the extent to which benefits of the action would be on-site, in-kind, or would be otherwise comparable in nature, scope, and location to injuries that occurred. Evaluation of each restoration action also considered the full range of potentially affected resource categories, even if no injury assessment was completed for that category.

Consistency with Restoration Strategy - Considers the degree to which a restoration action relates to the identified restoration strategy of providing on-site, in-kind restoration whenever possible and, if not possible, of providing appropriate restoration consistent with larger ecosystem restoration plans.

Consistency with Community Objectives - Considers the degree to which a given restoration action is consistent with known or anticipated community objectives. Community objectives are derived from larger ecosystem restoration plans as well as concerns for restoration planning articulated by members of the public, such as through the ARBSC or from public review and comment on the draft restoration plan.

Multiple Benefits - Considers the extent to which a given restoration action will address more than one natural resource injury or loss or benefit other resources, including those potentially affected.

Technical Feasibility - Considers both the likelihood that a given restoration action will succeed in a reasonable period of time, and the availability of technical expertise, programs and contractors to implement the considered action. This factor includes, but is not limited to, consideration of prior experience with methods or techniques proposed for use, availability of equipment and materials, site availability and logistical difficulty.

Restoration Site Requirements - Considers the extent to which the scientific, engineering or legal requirements of proposed restoration action can be met by available sites.

Potential for Additional Natural Resource Injury - Considers the risk that a proposed action may aggravate or cause additional natural resource injuries.

Restoration is Self-sustaining - Considers the degree to which a restoration action will achieve success without human intervention.

Consistency with Applicable Laws and Policies - Considers the extent to which a restoration action is consistent with relevant State, Federal and County policies and would be implemented in accordance with State, Federal and County laws.

Potential Effects on Human Health and Safety - Considers the potential adverse impacts a restoration action may have to human health and safety.

Costs Effective - Considers the relationship of costs associated with a given restoration alternative to the benefits of that alternative and the ability to achieve restoration objectives. Other factors being substantially equal, a less costly restoration approach is rated higher.

Based on this evaluation, this DARP/EA identifies the restoration alternatives which have been selected for use to achieve restoration objectives for the injured resources and, in turn, will be used as the basis for defining compensation for these injuries.

5.3 Screening Restoration Alternatives

The Agencies used a numerical scoring approach in screening the broader list of restoration alternatives. This approach accomplished several objectives. First, numerical scoring provides a means by which criteria can be applied to a specific restoration approach. Second, it allows for comparison among dissimilar restoration approaches. Once all restoration approaches are scored, it is easier to compare one, many, or all evaluation factors between potential approaches. Finally, numerical scoring provides an objective basis upon which to narrow the list of restoration alternatives for detailed consideration.

The numeric scale is based upon qualitative descriptors, not quantitative measures. Restoration alternatives were evaluated on a 0 to 3 scale depending on how well a restoration alternative fit a criterion. Using the scale and a worksheet developed for this purpose, each Agency as well as MPI scored all ten (10) of the potential restoration alternatives on each of the eleven (11) selection criteria identified in Section 5.2.1. Upon completion, the scores for each restoration alternative, per criterion, were combined and averaged and recorded on a final worksheet. In this final worksheet, a cumulative total score for each restoration approach is calculated by adding the eleven (11) averaged, per criterion scores for each alternative. The restoration alternatives with the highest five overall scores were selected for further consideration in development of an appropriate restoration plan for injured resources. As noted previously, these five alternatives were Restoration of Riverine Habitat, Restoration of Estuarine Wetlands, Reef Creation, Land Acquisition, and Surface Water Improvement Projects.

6.0 RESTORATION PLAN

The Agencies considered each of the five restoration alternatives with reasonable potential to achieve restoration objectives for resources injured by this incident (identified as described in Section 5.0) and the "no action" alternative. Consideration of the "no action" alternative in the restoration planning process is required by NEPA. The Agencies evaluation of these alternatives has taken into account the relationship to primary and compensatory restoration objectives applicable to each resource injury or loss, the selection criteria identified in Section 5.2.1, the benefits to other resources which were or may have been affected by the spill (i.e. benthic invertebrates, birds, recreational fishing, and oysters/mussels) and, consistent with its dual role as an EA under NEPA, other information bearing on the environmental setting for restoration and the potential environmental, social, or economic consequences of each alternative.

This section of the DARP/EA identifies those restoration alternatives which, based on that evaluation, have been selected for use to restore the natural resources or resource services which were injured or lost as a result of this incident. The alternatives evaluated by the Agencies and the rationale supporting the choice of the selected alternatives are presented in this section.

6.1 Restoration Objectives for Injured Resources

Primary Restoration Objectives

The goal of a primary restoration action is to facilitate recovery or otherwise assist an injured natural resource or service return to its baseline or pre-spill condition. Agencies may rely on the natural recovery process where injured resources or services will recover within a reasonable period without further action, or in situations where feasible or cost-effective primary restoration actions are not possible. As part of their assessment, the Agencies considered whether actions to assist injured freshwater wetlands, fishery species and surface waters recover to baseline were needed or appropriate.

For each injury category, the Agencies generally found natural recovery processes would allow resources and services to return to baseline conditions without human intervention, within a reasonable period of time. Surface water monitoring data indicates pH levels in the Alafia River returned to normal within weeks of the spill and that chlorophyll *a* concentrations related to the spill were nearing normal levels in Tampa Bay by May 1998. With respect to the injured freshwater vegetation, the Agencies believe, based on technical literature, expertise, and information from limited additional field work in early 1999, that ground cover, which comprised most of the freshwater wetland vegetation injury, will recover naturally within 2 years and subcanopy species will recover naturally in 5 years. Lastly, as noted in section 3.2.3, the assessed losses of Fish, Crab, and Shrimp are, for a number of reasons, not considered large enough to significantly alter future reproduction or recruitment in the river. Consequently, dedicated action to facilitate an overall return to pre-spill population levels is not required. However, after weighing many factors, a limited early stocking effort to directly replace snook of greater than 10" was approved as an appropriate primary restoration action. As described in Section 3.2.2, this early restoration action served to partially offset the kill of similar-sized snook and assist in reducing future production losses attributable to the fish kill. With the exception of this early action to replace dead snook, no other need or appropriate action to facilitate or assist the recovery of any injured resource or service has been identified by the Agencies.

Compensatory Restoration Objectives

The goal of compensatory restoration in this DARP/EA is to restore, replace or acquire natural resources or services like those injured as a result of the spill as a basis for compensating for the interim losses of natural resources and resource services which occurred. The scale of a compensatory restoration action depends on both the nature and extent of the resource injury and how quickly each resource and its associated services return to baseline.

For resource injuries addressed in this plan, the following objectives were used in identifying compensatory restoration actions:

(1) Provide freshwater vegetation services of higher quality (higher diversity) as a basis for compensating for the interim loss of freshwater wetland services;

(2) Replace the biomass of fish, crabs and shrimp lost due to the spill through creation or enhancement of habitat(s) capable of generating an equivalent biomass over time.

(3) Provide for the removal of nitrogen from surface waters over time in a manner sufficient to offset the amount of nitrogen introduced into the system by the spill.

6.2 No Action Alternative

Under this alternative, the Agencies would take no direct action to restore injured resources or to compensate for lost resource services pending their ecological recovery. Only natural recovery occurs under this option. Interim losses are not compensated.

Under laws applicable to public natural resource damage claims, the Agencies are responsible for seeking compensation for interim losses where these losses are significant and where feasible, cost-effective alternatives are available for use to define restoration-based compensation. While natural recovery will appropriately meet primary restoration objectives for all injured resources but one in this instance (i.e., early restoration action re: snook), the no action alternative will not satisfy any of the compensatory restoration objectives outlined above and was rejected on that basis.

6.3 Restoration of Riverine Habitat - Selected Alternative for Restoration of Freshwater Wetlands and Surface Water Services

Restoration of riverine habitat may be accomplished by converting non-native uplands, such as agricultural lands or filled historic riverine habitat, into freshwater floodplain wetlands, or returning disturbed vegetative communities (i.e., nuisance or exotic species dominated) back to an original or more desirable wetland community structure. Excavation, planting and monitoring to achieve restoration success are the major components of such projects. The Agencies have selected restoration of riverine habitat as the best approach for restoring interim losses associated with the injured freshwater vegetation described in Section 3.1 and the injury to surface waters described in Section 3.3.

Restoration of riverine habitat, for the purposes of this DARP/EA, shall not include the conversion of native coastal uplands, native riparian river buffers, or other types of native wetlands habitats into another less common wetlands type of less maturity. This decision is based on the desire to preserve the integrity of existing native habitats with important wildlife habitat services.

6.3.1 Evaluation of Alternative

For Freshwater Wetlands

The die-off of freshwater wetland vegetation caused by the spill represents an interim loss of ecological services associated with that vegetation. Action to restore or create riverine habitat is the most direct way to restore or replace ecological services comparable to those lost due to the spill. Pre-spill, the ecological services in these areas were largely provided by nuisance vegetation, with minimal habitat diversity.

Current permitting practices ensure the restoration or creation of riverine habitat will achieve the restoration objective for the lost freshwater wetland services by allowing only native, non-nuisance vegetation to be used in a riverine habitat project. This is an efficient means of replacing or acquiring ecological services like those lost as it will compensate for the services lost by improving the quality of wetland vegetation and, in turn, enhance the future flow of ecological services provided by restored areas. The increased quality of ecological services provided through riverine habitat restoration can be captured by measures of vegetative diversity.

Florida's mandatory program for the reclamation of mined lands has greatly advanced the science of freshwater wetland restoration. Many of the advances in wetland restoration technology on mined lands comes from work sponsored by the Florida Institute of Phosphate Research (FIPR) or phosphate mining companies undertaking reclamation in Florida. As a result, projects to restore or create riverine habitat are feasible and have been successful in meeting restoration goals. The expertise necessary to plan, implement or oversee such a project is also available. The Agencies have identified a number of areas in the Alafia River watershed suitable for siting a potential riverine restoration project. The available restoration technology and the opportunity to conduct meaningful riverine restoration constitute an important basis for selecting this approach as the preferred alternative.

A riverine habitat project dominated by herbaceous vegetation may be at risk of reverting to undesirable or nuisance species over time. The long-term sustainability of a riverine restoration or creation project is important and requires consideration of the future management of nuisance vegetation. The desire for such a project to be self-sustaining after a reasonable period of time, however, can be achieved through appropriate project design features. Richardson et al. (1994 and 1998) suggests that long term nuisance species control may be achieved by incorporating trees capable of shading out nuisance species. Nuisance species such as primrose willow can be controlled in 4 to 5 years using this approach. Accordingly, a mixed forested wetland may be the most appropriate target community to achieve long-term project success.

For Surface Waters

The imbalance in natural aquatic fauna in the Alafia River and in Tampa Bay through May of 1998, due in part to the increased nitrogen loadings from the spill, represent an interim loss ecological services associated with surface waters. Restoration projects that actively assimilate and remove nitrogen from surface waters are the most direct way to restore or replace ecological services comparable to the those lost.

The ability of both natural and created wetlands to remove nitrogen, as well as other pollutants, from surface waters has been well documented in the literature (Carr and Rushton 1995, Kadlec and Knight, 1996). Although some freshwater wetland community types are better at removing nitrogen than others, the Agencies believe there is strong evidence indicating that restored riverine habitat will function efficiently to remove nitrogen from surface waters and, therefore, represents the best and most sustainable approach for restoring surface water services in the Alafia River watershed. Measures of nitrogen removal can be used to capture the enhancement of surface water services. .

A riverine restoration project need not be sited in areas directly affected by the spill to provide improved surface water services in the affected riverine system. Any tributary with elevated levels of nitrogen and other pollutants could be targeted to maximize the improvements to surface water. A riverine restoration project located anywhere in the Alafia River watershed would enhance surface water services in the affected system and compensate for the interim lost surface water services in both the Alafia River and Tampa Bay. Utilizing vegetation with the highest capacity for or siting restoration in areas with the greatest need or potential for nitrogen removal, however, may increase restoration efficiency and help minimize the scale required to achieve restoration objectives.

Implementation of restoration of riverine habitat for either freshwater wetland or surface water injuries may require land acquisition.

6.3.2 Restoration Scaling

For Freshwater Wetlands

Potential riverine restoration projects for ground cover and subcanopy injuries would provide a higher quality level of vegetation services than those that were lost.[7] Instead of providing the less desirable monotypic vegetation characteristic of the injury site, the selected restoration approach would provide a wider array of more desirable species. Because the restoration will provide higher

[7] The restoration for the canopy injuries will provide similar quality resources and services as those that were lost.

quality vegetation, it is necessary to credit the restoration with the added quality. A diversity measure that was reported at the BOMR sampling stations (see description at Section 3.1.1) enables the Agencies to quantify the added quality of restoration. A measure of diversity – the Hill's ratio, which is a function of the Shannon Wiener index – was calculated for ground cover and subcanopy in Area A and Area B.[8] The measure is the average of the diversity indices for ground cover and subcanopy classes at the appropriate stations. With a measure of vegetation quality at the injury sites and also anticipated at the restoration sites, it is possible to determine the trade off of restoration habitat for injured habitat.[9] Lost diversity is closely correlated with other service losses (for example, suitability to support habitat functions declines as diversity diminishes). Diversity measures can also capture quality differences between injured and compensatory restoration sites.

The restored or replacement services would be of comparable value to the lost services. The restoration is likely to occur within the same landscape context as the injury area so the restoration will have the opportunity to provide the ecological services that were lost, e.g., nutrient uptake, habitat, and diversity. The ability of the restoration to provide the same opportunity for services relative to the injury site subsequently influences the value of services. Under these conditions, HEA is appropriate for determining the size of the restoration projects. Given parameters of the restoration projects, including year of implementation, years to functional maturity, and level of quality (or diversity), the scale of restoration that provides the equivalent of the lost vegetation services can be determined.

For Surface Water

HEA will also be used to determine the size of the restoration project necessary to address the surface water injury, consistent with the preferred restoration alternative. The quantity of nitrogen released into the surface water will be used as a metric, or unit of analysis. For the selected restoration action, the analysis will determine the project scale necessary to remove an equivalent amount of nitrogen from surface water runoff over the expected lifespan of the restoration project. The calculation of restoration scale will be dependent, in part, on the treatment efficiency of the restoration action (i.e., the ability of the restoration action to remove nitrogen from surface water) and will be based upon literature values. The use of HEA is appropriate since, under the preferred restoration alternative, restoration actions are expected to result in the uptake of nitrogen from surface waters, an ecological function of the same type and quality, and of value comparable to the interim injury to surface water caused by the spill.

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8 The Hill's ratio is $\frac{1/\lambda}{e^{H'}}$ where H' is the Shannon-Wiener index and λ is $\sum_{i=1}^{s} p_i^2$; p_i is the proportional abundance of the ith species and was estimated using the relative abundance of a species as a proportion of total cover for each cover class. The ratio is decreasing in diversity and converges toward one as one species dominates. We report the diversity measure as one minus the Hill's ratio so the diversity index is increasing in diversity.

9 For the canopy injury and restoration, no quality measurements are needed since the restoration for the canopy injury is expected to provide the same quality of vegetation as that which was lost.

Implementation of Scaling

In scaling for freshwater vegetation losses and surface water injuries under this alternative, the Agencies recognize that restoration projects selected to restore or replace the lost vegetative services will also function to provide for nitrogen removal and that the extent to which this occurs must be taken into account in the scaling process. In scaling the restoration required to compensate for the surface water service losses, credit must be given for any nitrogen removal contributed by projects selected to address the lost vegetation services. This is necessary to avoid overcompensating for surface water losses under the proposed restoration plan.

6.3.3 Environmental and Socio-Economic Impact

Restoration of riverine habitat is likely to involve the temporary use of equipment, such as trucks or other machinery, which will potentially increase noise, dust, and traffic in the immediate project vicinity. The site would be transformed from a non-native upland or degraded wetland into a freshwater marsh, forested floodplain wetland or similar habitat. The ecological benefits of such a riverine project will support or contribute to the overall health of the ecosystem in the Alafia River basin and in Tampa Bay. This indirectly benefits humans by enhancing opportunities for recreation and enjoyment of these areas through activities such as boating, bird watching, and fishing and by helping to support property values and use, tourism and water dependent commercial activities. This alternative, however, would not have any significant socio-economic impacts.

6.4 Restoration of Estuarine Wetlands - Co-Selected Alternative for Restoration of Fish, Crab, and Shrimp Biomass Lost

This alternative involves converting non-native uplands or previously filled wetlands into tidally-influenced habitat, or replacing nuisance or exotic-dominated vegetation communities in estuarine areas with more productive estuarine vegetation. The Agencies have selected estuarine habitat restoration as one of two alternatives for use to restore the biomass of fish, crab, and shrimp lost as a result of the spill, as described in Section 3.2.

6.4.1 Evaluation of Alternative

Restoration of estuarine wetlands is a proven and successful strategy for increasing the types of habitat, such as salt marsh, considered critical to the life history of many species of fish, shellfish and shrimp found in the estuary and to the recruitment and production of such species in the estuarine environment. The linkage between fishery productivity and estuarine wetlands, such as smooth cordgrass (*Spartina alterniflora*) marshes, is generally accepted, with productivity values or estimates associated with spartina marshes considered to be among the highest for estuarine habitats. As such, the Agencies consider action to restore or create estuarine wetlands as one of the most direct and ecologically efficient ways to restore or replace the fishery biomass lost due to the spill.

Restoration of estuarine wetlands is feasible both from a technical standpoint and in its ability to restore injured resources. The Agencies consulted with the SWFWMD, which has an existing estuarine habitat restoration program, during development of this DARP/EA and found that there are present opportunities to successfully create or restore estuarine wetlands within one to two miles of the mouth of the Alafia River. These opportunities involve the creation or restoration of salt marsh habitat, with gradual transition over time to a mixed wetland community dominated by mangroves. These projects are also believed to function well when compared to natural systems. Although potentially well suited to the restoration objectives for fishery losses, restoration projects which are ongoing or in an advanced state of planning, such as those identified by SWFWMD, would be ineligible for use to implement restoration under this alternative if funding to implement these actions is or becomes available from other sources. Further, the planning, funding and schedule for implementation of these projects is not within the control of the Agencies. As such, determining the costs to implement estuarine habitat restoration for public claim purposes requires the Agencies to identify such costs based on the development and implementation of new restoration projects. These, however, may be patterned after other successfully designed projects and the scientific, engineering and legal requirements associated with most new restoration projects can be efficiently addressed at reasonable cost by partnering with SWFWMD or others to assist in the design and implementation of this restoration alternative. Based on experience with other estuarine wetland restoration projects, it is anticipated this restoration alternative will be self-sustaining after 5 to 7 years, with limited maintenance activities or other active intervention required during that period. Because such projects are primarily designed to benefit or improve ecological resources, no human health or safety issues would exist beyond the construction phase.

Restoration of estuarine wetlands is consistent with other identified ecosystem restoration objectives (i.e., the Comprehensive Conservation and Management Plan for Tampa Bay [CCMP] and the Surface Water Improvement & Management Program [SWIM]). Indeed, restoration of estuarine wetlands is a key part of several larger ecosystem restoration plans for the Tampa Bay estuary, in part, because such habitats are so essential to healthy fisheries.

As with any restoration action, implementation may adversely affect natural resources for some period of time, particularly if it involves earth moving or other physical activities in or adjacent to existing wetlands. Short-term negative impacts may include loss of non-native upland vegetation, temporary increases in water turbidity and temporary losses of water quality services. Such impacts are generally minimized through planning and during implementation. In the longer term, the benefits of restoring or creating estuarine wetlands - i.e., providing habitat essential to healthy fisheries, bird nesting and foraging areas and other wildlife habitat, assisting in maintaining surface water quality, and supporting recreational activities - outweigh any short term impacts.

The costs of restoring estuarine wetlands may be less on a per acre basis than for restoration such as reef creation. However, if estuarine wetlands do not restore the fishery biomass more efficiently, the cost of implementing this alternative may be comparable to the cost of other alternatives because more estuarine acreage would be needed to restore the fish biomass loss. Cost efficiencies may be achieved through partnering with pending restoration projects, which would tend to further minimize the costs of this option. It is more likely, however, that the Agencies must proceed with new projects that may for instance, require land acquisition, which would drive up restoration costs dramatically.

The Agencies determined that restoration of estuarine wetlands in combination with the creation of new oyster reef habitat is the most efficient and best means to provide for the restoration of the fish biomass lost. This determination is supported by work undertaken since release of the Draft DARP/EA. This work took into account available scientific data and evidence bearing on the relative annual secondary productivity between oyster reef habitat and artificial reefs in light of similar information on estuarine wetlands. It also took into account the data and evidence regarding species utilization associated with these habitats and the species killed by the spill. The work indicated oyster reef would likely be the most productive of the habitats under consideration and would provide habitat and ecological services to the greatest number of the species killed. It also indicated estuarine wetland habitat services would likely better support those species lost which are not supported by oyster reef habitat. The combination of oyster reef and estuarine habitat restoration, therefore, will benefit more of the fish species lost than either restoration alternative alone or any other combination of restoration alternatives, including artificial reefs and seagrass restoration.

6.4.2 Restoration Scaling

Estuarine wetlands restoration will provide the same type of and quality of resources and services as were lost as a result of the spill (e.g., production of fish, blue crab and pink shrimp). HEA will be used to determine the size of the restoration project. Where fish, blue crab and pink shrimp losses are quantified in terms of the biomass (kg wet weight) directly lost or not produced, HEA allows the scale of the selected restoration to be based on the anticipated production of fishery biomass. The use of HEA is appropriate since the selected restoration alternatives are expected to produce or enhance fish, blue crab and pink shrimp productivity, providing resources and services of the same type and quality, and of value comparable to those lost. Further, where the services lost and those provided at restoration sites might differ, HEA can account for those differences and, thus, remains an appropriate scaling tool.

6.4.3 Environmental and Socio-Economic Impact

Restoration of estuarine wetlands is also likely to involve the temporary use of equipment, such as trucks or other machinery, which will potentially increase noise, dust, and traffic in the immediate project vicinity. The site would be transformed from a non-native upland or degraded wetland into an intertidal salt marsh or mangrove habitat. The ecological benefits of such a project will also support or contribute to the overall health of the ecosystem in the Alafia River basin and in Tampa Bay and indirectly benefit humans by contributing to opportunities for recreation and enjoyment of these areas through activities such as boating, bird watching, and fishing and by helping to support property values and use, tourism and water dependent commercial activities. This alternative, however, would not have any significant socio-economic impacts.

6.5 Oyster Reef Creation - Co-Selected Alternative for Restoring Fish Biomass Lost

As outlined in the Draft DARP/EA, this alternative includes the placement of hard substrate as three dimensional structure in open water, on shorelines or in intertidal areas for the purpose of creating productive fish habitat. Restoration actions of this nature could be located in either freshwater or estuarine portions of the Alafia River or in Tampa Bay in the vicinity of the river. Artificial reef material can be anything from engineered or designed concrete structures to fossilized oyster shells, subject to consistency with government regulatory and/or resource enhancement programs.

Based on the Agencies' consideration of such factors as the relative productivity of oyster reef and artificial reef habitats, the ecological support for species killed by the spill and public comments on the Draft DARP/EA, the Agencies have identified oyster reef creation as the co-selected restoration alternative to provide for restoration of the fish biomass lost.

6.5.1 Evaluation of Alternative

Reef creation - whether accomplished through reestablishment or creation of oyster reefs or the creation of three dimensional artificial reef structures - can provide fish habitat, contribute to improving surface water quality, enhance recreational opportunities and result in the production of new fishery biomass. The primary benefits of reef creation and the resources served, however, may be somewhat different, depending on the type of reef created. Artificial reef structures primarily serve to provide three dimensional habitat for fish and other aquatic fauna. Encrusting or fouling communities such as sponges, bryozoans, corals, oysters and mussels will rapidly colonized hard, artificial reef substrates and such habitats will attract fish, a function which enhances recreational fishing opportunities. Created reef areas can enhance the availability of prey items or create new foraging opportunities. Schooling fish associated with reefs, for instance, provide prey items for larger fish species and intertidal or shallow reefs will support worms, crabs, shrimp, small fish and other organisms which are a forage base for wading and shore birds. Where created reefs are designed to recruit and support oysters, in addition to re-establishing or creating historic oyster reef communities, these reef would improve surface water quality directly since oysters are filter feeders and assist in removing suspended sediments from the water column. Similarly, different types of reefs may vary in terms of their potential contribution to fishery production.

The nature and extent to which a created reef is capable, through fishery production, of restoring the fish biomass lost is a key consideration in this restoration plan. For artificial reef structures in particular, much has been written and debated about their 'fish attraction' versus 'fish production' function. Without resolving larger issues implicated in debate over these functions, the Agencies recognize that reef habitats, including those utilizing artificial substrates, support complex interactions in the marine or estuarine environment and that significant fisheries production may, in fact, occur. Further, created reefs, particularly if sited in shallower, low energy areas in the estuarine portion of the Alafia River or in Tampa Bay, have the potential to support a mix of species similar to those lost due to the spill.

In general, all reef creation projects are technically feasible, with designs ranging from simple oyster bars to complex artificial structures designed by interdisciplinary teams of biologists, engineers, and oceanographers. The creation of reefs, and oyster reefs in particular, has been specifically identified as a part of a larger ecosystem restoration strategy for Tampa Bay (Tampa Bay National Estuary Program, 1996), which encourages the identification, protection and restoration of hardbottom communities. Reef creation actions, particularly artificial reefs, are also generally popular with the recreational fishing community. Although cost will be dependent on a number of factors including design, size, location, material type, transportation or deployment costs, reef creation may be comparable on a per acre basis to other restoration alternatives. Areas suitable for creation of oyster reefs appear to exist in the Alafia River and in other nearby areas of Tampa Bay. Created reef habitat would be self sustaining in the long term, given a type or design appropriate to the depth and physical extremes (e.g., current velocity, wave energy, etc.) to which it will be subject. Conditions affecting stability can also be minimized through sound site selection.

Created reefs are usually permanent habitats which displace some other type of submerged habitat. Reefs are usually sited in sand or relatively 'barren' bottom areas to ensure that the action results in greater or enhanced services to the environment. Existing regulatory (permitting) processes normally will restrict reef creation to areas with a low potential for additional resource injury. Habitat displacement/replacement, however, would likely be a critical factor weighing against use of this restoration alternative if the scale of reef creation required to restore the fish biomass lost proves to be very large. In that event, the costs associated with a large reef project may also weigh against use of this alternative.

Work undertaken since release of the Draft DARP/EA indicates that reef creation actions encompassed by this alternative are not equivalent in terms of their ability to provide for the production of fish biomass or to achieve restoration objectives for the species killed by the spill. This work considered available scientific data and evidence bearing on the relative annual secondary productivity between oyster reef habitat and artificial reefs. Productivity estimates based on that information indicated that oyster reefs were likely to be more efficient at restoring fish biomass than constructed artificial reefs, accounting for fishing pressure (225 $g/m^2/yr$ vs. 171.0 $g/m^2/yr$). In addition, data and evidence regarding species utilization associated with these different reef types and the species killed by the spill indicates oyster reef would ecologically support more of the species killed by the spill than constructed artificial reef habitat. Together with public comments on the Draft DARP/EA which also favored its use, this information led the Agencies to identify oyster reef creation as the most efficient type of reef creation for use, in combination with the restoration of estuarine wetlands, to provide for restoration of the fish biomass lost.

6.5.2 Restoration Scaling

Oyster reef creation would provide the same type of and quality of resources and services that were injured as a result of the spill e.g., production of fish, blue crab and pink shrimp. HEA will be used to determine the size of the restoration project. Where fish, blue crab and pink shrimp losses are quantified in terms of the biomass (kg wet weight) directly lost or not produced, HEA